# PRESTATIEVERKLARING

## DoP 0351

voor fischer injectiesysteem FIS EM PLUS (Verbindingsbevestiging voor gebruik in beton) NL

1. Unieke identificatiecode van het producttype: **DoP 0351**

2. Beoogd(e) gebruik(en): **Bevestigingen in gescheurd of ongescheurd beton, zie bijlage, met name de bijlagen B1 - B17.**

3. Fabrikant: **fischerwerke GmbH & Co. KG, Otto-Hahn-Straße 15, 79211 Denzlingen, Duitsland**

4. Gemachtigde: **–**

5. Het systeem of de systemen voor de beoordeling en verificatie van de prestatiebestendigheid: **1**

6. Europees beoordelingsdocument: **EAD 330499-02-0601, Edition 12/2023**
   Europese technische beoordeling: **ETA-17/0979; 2024-04-22**
   Technische beoordelingsinstantie: **DIBt- Deutsches Institut für Bautechnik**
   Aangemelde instantie(s): **2873 TU Darmstadt**

7. Aangegeven prestatie(s):

**Mechanische weerstand en stabiliteit (BWR 1)**

**Kenmerkende weerstand tegen trekbelasting (statische en quasi-statische belasting):**

1) Weerstand tegen staalbreuk: zie bijlage, met name de bijlagen C1, C2, C3, C19, C21, C23
2) Weerstand tegen gecombineerd uittrekken en betonnen kegelbreuk: zie bijlage, met name de bijlagen C4 - C16, C24 - C34
3) Weerstand tegen betonnen kegelbreuk: zie bijlage, met name bijlage C4, C24
4) Randafstand om spleetbreuk onder belasting te voorkomen: zie bijlage, met name bijlage C4, C24
5) Robuustheid: zie bijlage, met name de bijlagen C4 - C16, C24 - C34
6) Maximaal montagekoppel: zie bijlage, met name de bijlagen B3, B4, B8, B9, B12
7) Minimale rand- en hartafstand, Dikte van het onderdeel: zie bijlage, met name de bijlagen B3 - B12

**Kenmerkende weerstand tegen schuifbelasting (statische en quasi-statische belasting):**

8) Weerstand tegen staalbreuk: zie bijlage, met name de bijlagen C1, C2, C3, C20, C22, C23
9) Weerstand tegen uitbreken (pryout): zie bijlage, met name de bijlagen C4, C24
10) Weerstand tegen bezwijken van betonranden: zie bijlage, met name de bijlagen C4, C24

**Verplaatsingen onder korte- en langetermijnbelading:**

11) Verplaatsingen onder korte- en langetermijnbelading: zie bijlage, met name de bijlagen C17, C18, C35, C36
12) Weerstand in staalvezelversterkt beton: NPD

**Kenmerkende weerstand en verplaatsingen voor de seismische prestatiecategorieën C1 en C2:**

13) Trekkrachtweerstand, categorie C1: zie bijlage, met name de bijlagen C37 - C41, C43 - C47
14) Trekkrachtweerstand, categorie C2: zie bijlage, met name de bijlagen C38, C39, C42
15) Weerstands afschuifbelasting, categorie C1: zie bijlage, met name de bijlagen C37 - C39, C43 - C45
16) Weerstands afschuifbelasting, categorie C2: zie bijlage, met name de bijlagen C38, C39

**Veiligheid in geval van brand (BWR 2)**

17) Reactie op brand: Klasse (A1)

**Weerstand tegen vuur:**

18) Weerstand bij brand, staalbreuk (trekbelasting): zie bijlage, met name de bijlagen C48 - C51
19) Weerstand tegen hechting onder brandomstandigheden: zie bijlage, met name bijlage C51
20) Weerstand bij brand, staalbreuk (afschuifbelasting): zie bijlage, met name de bijlagen C48 - C51

**Hygiëne, gezondheid en milieu (BWR 3)**

21) Content, emission and/or release of dangerous substances: NPD

8. Geëigende technische documentatie en/of specifieke technische documentatie: **–**

De prestaties van het hierboven omschreven product zijn conform de aangegeven prestaties. Deze prestatieverklaring wordt in overeenstemming met Verordening (EU) nr. 305/2011 onder de exclusieve verantwoordelijkheid van de hierboven vermelde fabrikant verstrekt.

Ondertekend voor en namens de fabrikant door:

Dr.-Ing. Oliver Geibig, Directeur Business Units & Engineering

Jürgen Grün, Directeur Chemie & Kwaliteit

Tumlingen, 2024-05-06

Deze DoP is opgesteld in meerdere talen. In het geval van geschillen over de interpretatie zal de Engelse tekst altijd prevaleren.

Het aanhangsel bevat vrijwillige en aanvullende informatie in het Engels die de (taal-neutraal gespecificeerde) wettelijke vereisten overschrijdt.

Translation guidance Essential Characteristics and Performance Parameters for Annexes

**Vertaal assistent van de essentiële kenmerken en eigenschappen voor bijlagen**

| | | |
|---|---|---|
| Mechanical resistance and stability (BWR 1)<br>**Mechanische weerstand en stabiliteit (BWR 1)** | | |
| Characteristic resistance to tension load (static and quasi-static loading):<br>**Kenmerkende weerstand tegen trekbelasting (statische en quasi-statische belasting):** | | |
| 1 | Resistance to steel failure:<br>**Weerstand tegen staalbreuk:** | $N_{Rk,s}$ [kN] |
| 2 | Resistance to combined pull- out and concrete cone failure: | $\tau_{Rk}$ and/or $\tau_{Rk,100}$ [N/mm$^2$],<br>$\psi_c$, $\psi^0_{sus}$,$\psi_{sus,100}$ [-] (BF) |
| | Resistance to pull-out failure:<br>**Weerstand tegen uittrekken:** | $N_{Rk,p}$ and/or $N_{Rk,p,100}$ [kN], $\psi_c$ [-] (BEF) |
| 3 | Resistance to concrete cone failure:<br>**Weerstand tegen betonnen kegelbreuk:** | $c_{cr,N}$ [mm], $k_{cr,N}$, $k_{ucr,N}$ [-] |
| 4 | Edge distance to prevent splitting under load:<br>**Randafstand om spleetbreuk onder belasting te voorkomen:** | $c_{cr,sp}$ [mm] |
| 5 | Robustness:<br>**Robuustheid:** | $\gamma_{inst}$ [-] |
| 6 | Maximum installation torque: | max $T_{inst}$ [Nm] (BF) |
| | Installation torque:<br>**Montagekoppel:** | $T_{inst}$ [Nm] (BEF) |
| 7 | Minimum edge distance,spacing and member thickness:<br>**Minimale rand- en hartafstand, Dikte van het onderdeel:** | $c_{min}$, $s_{min}$, $h_{min}$ [mm] |
| Characteristic resistance to shear load (static and quasi-static loading):<br>**Kenmerkende weerstand tegen schuifbelasting (statische en quasi-statische belasting):** | | |
| 8 | Resistance to steel failure:<br>**Weerstand tegen staalbreuk:** | $V^0_{Rk,s}$ [kN], $M^0_{Rk,s}$ [Nm], $k_7$ [-] |
| 9 | Resistance to pry-out failure:<br>**Weerstand tegen uitbreken (pryout):** | $k_8$ [-] |
| 10 | Resistance to concrete edge failure:<br>**Weerstand tegen bezwijken van betonranden:** | $d_{nom}$, $l_f$ [mm] |
| Displacements under short-term and long-term loading:<br>**Verplaatsingen onder korte- en langetermijnbelading:** | | |
| 11 | Displacements under short-term and long-term loading:<br>**Verplaatsingen onder korte- en langetermijnbelading:** | $\delta_0$, $\delta_\infty$ [mm or mm/(N/mm$^2$)] |
| 12 | Resistance in steel fibre reinforced concrete:<br>**Weerstand in staalvezelversterkt beton:** | Description |
| Characteristic resistance and displacements for seismic performance categories C1 and C2:<br>**Kenmerkende weerstand en verplaatsingen voor de seismische prestatiecategorieën C1 en C2:** | | |
| 13 | Resistance to tension for seismic performance category C1<br>**Trekkrachtweerstand, categorie C1:** | $N_{Rk,s,C1}$ [kN] (all)<br>$\tau_{Rk,C1}$ [N/mm$^2$] (BF)<br>$N_{Rk,p,C1}$ [kN] (BEF) |
| 14 | Resistance to tension for seismic performance category C2<br>**Trekkrachtweerstand, categorie C2:** | $N_{Rk,s,C2}$ [kN] (all)<br>$\tau_{Rk,C2}$ [N/mm$^2$] (BF)<br>$N_{Rk,p,C2}$ [kN] (BEF)<br>$\delta_{N,C2}$ [mm] (all) |
| 15 | Resistance to shear for seismic performance category C1<br>**Weerstands afschuifbelasting, categorie C1:** | $V_{Rk,s,C1}$ [kN] (all) |
| 16 | Resistance to shear for seismic performance category C2<br>**Weerstands afschuifbelasting, categorie C2:** | $V_{Rk,s,C2}$ [kN] (all)<br>$\delta_{V,C2}$ [mm] (all) |
| Safety in case of fire (BWR 2)<br>**Veiligheid in geval van brand (BWR 2)** | | |
| 17 | Reaction to fire<br>**Reactie op brand:** | Class<br>Klasse (A1) |
| Resistance to fire<br>**Weerstand tegen vuur:** | | |
| 18 | Fire resistance to steel failure (tension load):<br>**Weerstand bij brand, staalbreuk (trekbelasting):** | $N_{Rk,s,fi}$ [kN] |
| 19 | Bond resistance under fire conditions:<br>**Weerstand tegen hechting onder brandomstandigheden:** | $k_{fi,p}$ ($\theta$) [-],<br>$\tau_{Rk,fi}$ ($\theta$) [N/mm$^2$] (BF) |
| 20 | Fire resistance to steel failure under shear loading:<br>**Weerstand bij brand, staalbreuk (afschuifbelasting):** | $V_{Rk,s,fi}$ [kN], $M^0_{Rk,s,fi}$ [Nm] |
| Hygiene, health and the environment (BWR 3)<br>**Hygiëne, gezondheid en milieu (BWR 3)** | | |
| 21 | Content, emission and/or release of dangerous substances:<br>**Content, emission and/or release of dangerous substances:** | Description/Level |

**Specific Part**

## 1 Technical description of the product

The "fischer injection system FIS EM Plus" is a bonded fastener consisting of a cartridge with injection mortar fischer FIS EM Plus and a steel element according to Annex A5.

The steel element is placed into a drilled hole filled with injection mortar and is anchored via the bond between metal part, injection mortar and concrete.

The product description is given in Annex A.

## 2 Specification of the intended use in accordance with the applicable European Assessment Document

The performances given in Section 3 are only valid if the anchor is used in compliance with the specifications and conditions given in Annex B.

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the anchor of at least 50 or 100 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

## 3 Performance of the product and references to the methods used for its assessment

### 3.1 Mechanical resistance and stability (BWR 1)

| Essential characteristic | Performance |
|---|---|
| Characteristic resistance to tension load (static and quasi-static loading) | See Annex B3 to B12, C1 to C16, C19, C21, C23, C24, C25 to C34 |
| Characteristic resistance to shear load (static and quasi-static loading) | See Annex C1 to C4, C20, C22, C23, C24 |
| Displacements under short-term and long-term loading | See Annex C17, C18, C35, C36 |
| Characteristic resistance and displacements for seismic performance categories C1 and C2 | See Annex C37 to C47 |

### 3.2 Safety in case of fire (BWR 2)

| Essential characteristic | Performance |
|---|---|
| Reaction to fire | Class A1 |
| Resistance to fire | See Annex C48 to C51 |

### 3.3 Hygiene, health and the environment (BWR 3)

| Essential characteristic | Performance |
|---|---|
| Content, emission and/or release of dangerous substances | No performance assessed |

## 4 Assessment and verification of constancy of performance (AVCP) system applied, with reference to its legal base

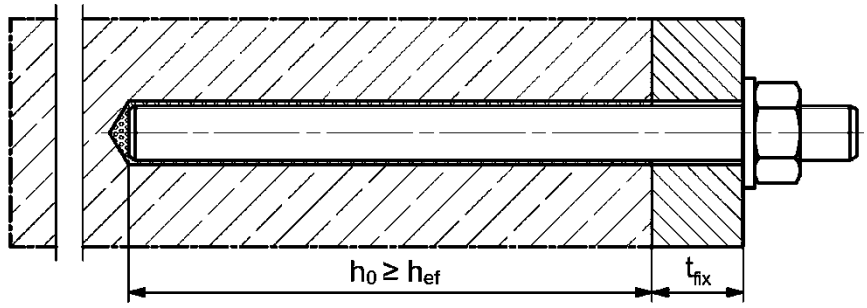
In accordance with the European Assessment Document EAD 330499-02-0601 the applicable European legal act is: [96/582/EC].

The system to be applied is: 1

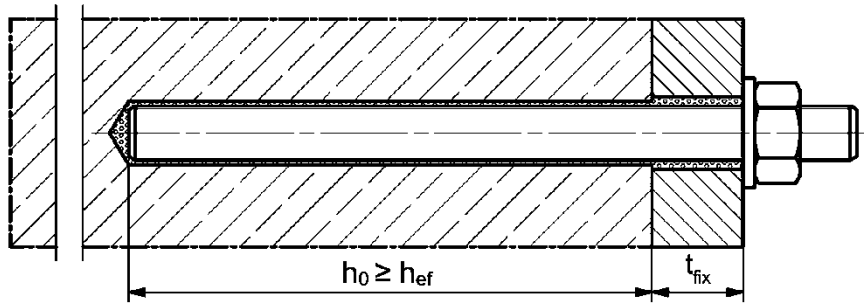
## Installation conditions part 1

**fischer Anchor rod FIS A / RG M (Anchor rod) and commercial standard threaded rod (Threaded rod)**

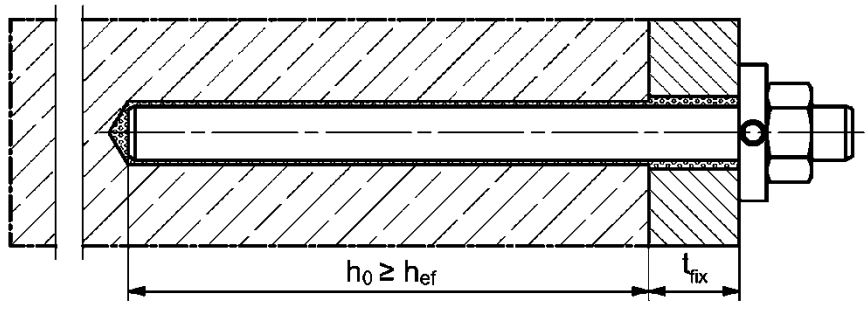
**Pre-positioned installation**




**Push through installation** (annular gap filled with mortar)




**Pre-positioned or push through installation with subsequently injected fischer filling disc** (annular gap filled with mortar)




Figures not to scale

$h_0$ = drill hole depth

$h_{ef}$ = effective embedment depth

$t_{fix}$ = thickness of fixture

fischer injection system FIS EM Plus

**Product description**
Installation conditions part 1

**Annex A1**

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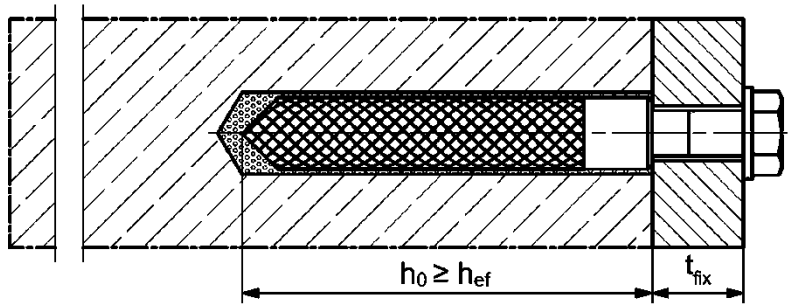
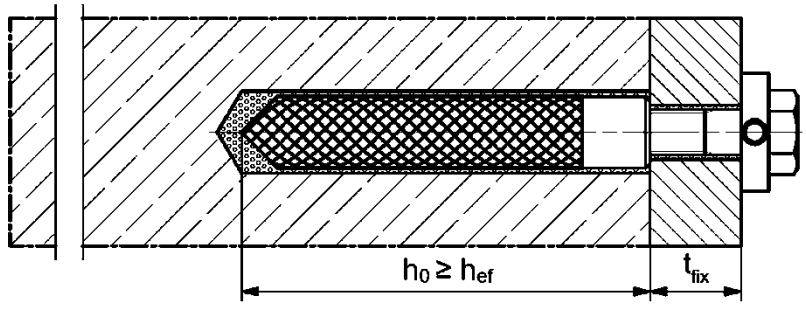
## Installation conditions part 2

**fischer internal threaded anchor RG M I (fischer RG M I)**

**Pre-positioned installation**




**Pre-positioned installation with subsequently injected fischer filling disc** (annular gap filled with mortar)




Figures not to scale

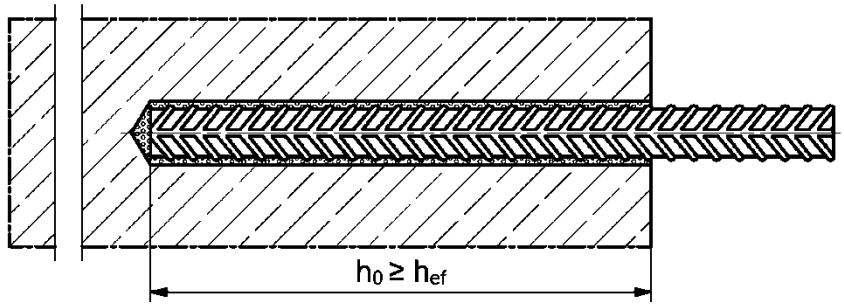
$h_0$ = drill hole depth

$h_{ef}$ = effective embedment depth

$t_{fix}$ = thickness of fixture

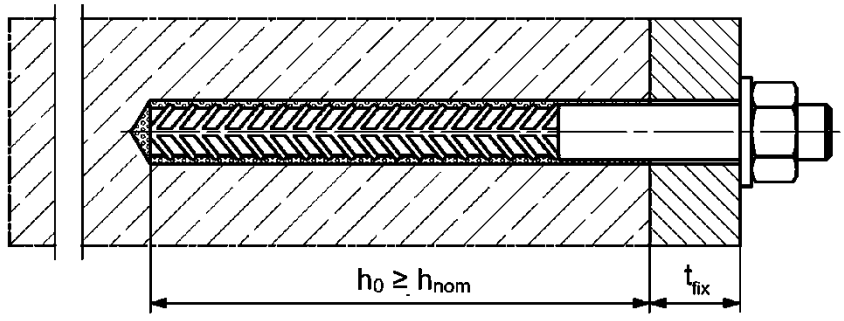
## Installation conditions part 3

**Reinforcing bar**

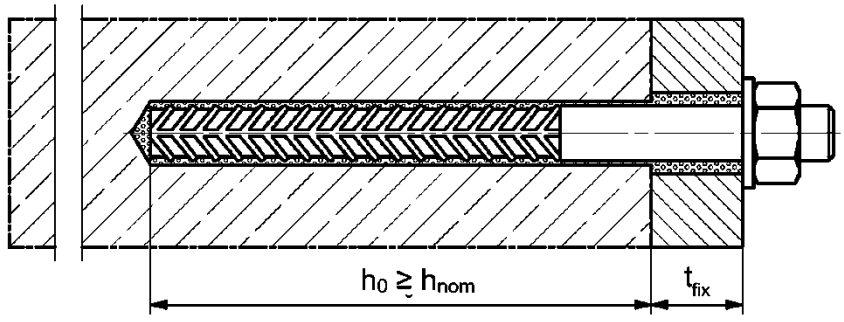



**fischer rebar anchor FRA (fischer FRA)**

**Pre-positioned installation**




**Push through installation** (annular gap filled with mortar)




Figures not to scale

$h_0$ = drill hole depth

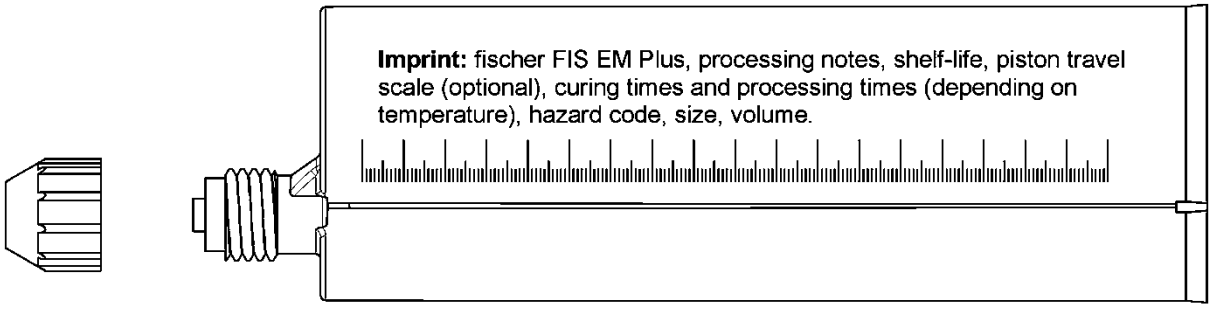
$h_{ef}$ = effective embedment depth

$t_{fix}$ = thickness of fixture

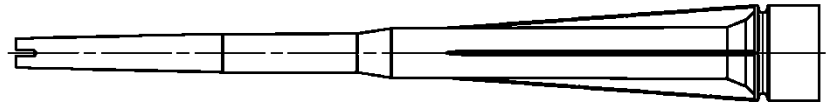
$h_{nom}$ = overall fastener embedment depth in the concrete

## Overview system components part 1

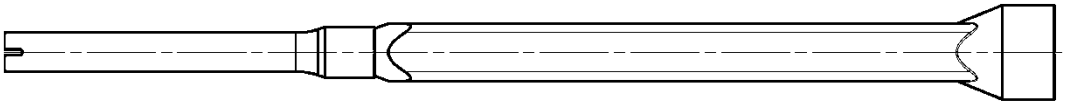
**Injection cartridge (shuttle cartridge) with sealing cap; Size: 390 ml, 585 ml, 1500 ml**



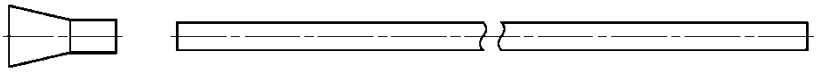

**Static mixer FIS MR Plus for injection cartridges ≤ 390 ml**



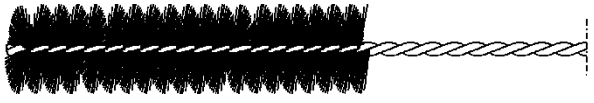
**Static mixer FIS UMR for injection cartridges > 390 ml**



**Injection adapter and extension tube Ø 9 for static mixer FIS MR Plus;**
**Injection adapter and extension tube Ø 9 or Ø 15 for static mixer FIS UMR**



**Cleaning brush BS / BSB**



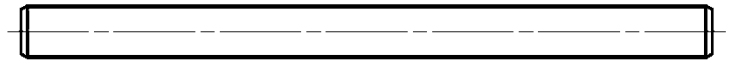
**Compressed-air cleaning tool ABP**

Figures not to scale

## Overview system components part 2

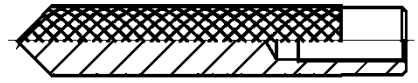
**Anchor rod / Threaded rod**

Metric size: M8, M10, M12, M14, M16, M20, M22, M24, M27, M30
Fractional size: 3/8", 1/2", 5/8", 3/4", 7/8", 1", 1 1/8"

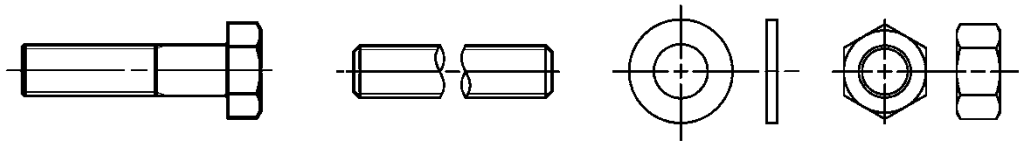


**fischer RG M I**

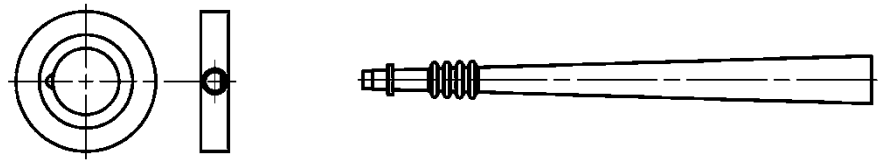
Metric size: M8, M10, M12, M16, M20
Fractional size: 3/8", 1/2", 5/8", 3/4"



**Screw / Anchor rod / Threaded rod / washer / hexagon nut**



**fischer filling disc with injection adapter**



**Reinforcing bar**

Nominal diameter:
Metric size: ϕ8, ϕ10, ϕ12, ϕ14, ϕ16, ϕ18, ϕ20, ϕ22, ϕ24, ϕ25, ϕ26, ϕ28, ϕ30, ϕ32, ϕ34, ϕ36, ϕ40
Fractional size: #3 (3/8"), #4 (1/2"), #5 (5/8"), #6 (3/4"), #7 (7/8"), #8 (1"), #9 (1,128"), #10 (1,270")

**fischer FRA**

Metric size: M12, M16, M20, M24

Figures not to scale

## Table A6.1: Materials, metric sizes

| Part | Designation | Material | | |
|---|---|---|---|---|
| 1 | Injection cartridge | Mortar, hardener, filler | | |
| | Steel grade | Steel<br>zinc plated (zp, hdg) | Stainless steel R<br>acc. to EN 10088-1:2014<br>Corrosion resistance class CRC III acc. to EN 1993-1-4: 2006+A2:2020 | High corrosion resistant steel HCR<br>acc. to EN 10088-1:2014<br>Corrosion resistance class CRC V acc. to EN 1993-1-4: 2006+A2:2020 |
| 2 | Anchor rod / Threaded rod | Property class 4.8, 5.8 or 8.8; EN ISO 898-1:2013<br>zp ≥ 5 µm, EN ISO 4042:2022 or hot dip galvanised ≥ 40 µm EN ISO 10684:2004+AC:2009<br>$f_{uk}$ ≤ 1000 N/mm²<br>$A_5$ > 12 % fracture elongation[1)] | Property class 50, 70 or 80; EN ISO 3506-1:2020<br>1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362; 1.4062; 1.4662; 1.4462; EN 10088-1:2014<br>$f_{uk}$ ≤ 1000 N/mm²<br>$A_5$ > 12 % fracture elongation[1)] | Property class 50, 70 or 80; EN ISO 3506-1:2020 or property class HCR 70 with $f_{yk}$= 560 N/mm²; 1.4565;1.4529; EN 10088-1:2014<br>$f_{uk}$ ≤ 1000 N/mm²<br>$A_5$ > 12 % fracture elongation[1)] |
| 3 | Washer ISO 7089:2000 | zinc plated ≥ 5 µm, EN ISO 4042:2022 or hot dip galvanised ≥ 40 µm EN ISO 10684:2004+AC:2009 | 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362; EN 10088-1:2014 | 1.4565; 1.4529; EN 10088-1:2014 |
| 4 | Hexagon nut | Property class 4, 5 or 8 acc. EN ISO 898-2:2012 zinc plated ≥ 5 µm, EN ISO 4042:2022 or hot dip galvanised ≥ 40 µm EN ISO 10684:2004+AC:2009 | Property class 50, 70 or 80 acc. EN ISO 3506-2:2020 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362; EN 10088-1:2014 | Property class 50, 70 or 80 acc. EN ISO 3506-2:2020 1.4565; 1.4529; EN 10088-1:2014 |
| 5 | fischer RG M I | Property class 5.8 EN ISO 898-1:2013 zinc plated ≥ 5 µm, EN ISO 4042:2022 | Property class 70 EN ISO 3506-1:2020; 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362; EN 10088-1:2014 | Property class 70 EN ISO 3506-1:2020 1.4565; 1.4529; EN 10088-1:2014 |
| 6 | Commercial standard screw or Anchor rod / Threaded rod for fischer RG M I | Property class 5.8 or 8.8; EN ISO 898-1:2013 zinc plated ≥ 5 µm, EN ISO 4042:2022 $A_5$ > 8 % fracture elongation | Property class 70 EN ISO 3506-1:2020 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362; EN 10088-1:2014 $A_5$ > 8 % fracture elongation | Property class 70 EN ISO 3506-1:2020 1.4565; 1.4529; EN 10088-1:2014 $A_5$ > 8 % fracture elongation |
| 7 | fischer filling disc similar to DIN 6319-G | zinc plated ≥ 5 µm, EN ISO 4042:2022 or hot dip galvanised ≥ 40 µm EN ISO 10684:2004+AC:2009 | 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362; EN 10088-1:2014 | 1.4565;1.4529; EN 10088-1:2014 |
| 8 | Rebar | EN 1992-1-1:2004 and AC:2010, Annex C<br>Bars and de-coiled rods, class B or C with $f_{yk}$ and k according to NDP or NCI according to EN 1992-1-1/NA; $f_{uk} = f_{tk} = k \cdot f_{yk}$ ($A_5$ > 12 %)[1)] | | |
| 9 | fischer FRA | Rebar part:<br>Bars and de-coiled rods class B or C with $f_{yk}$ and k according to NDP or NCI of EN 1992-1-1:2004+AC:2010<br>$f_{uk} = f_{tk} = k \cdot f_{yk}$ ($A_5$ > 8 %)<br>Threaded part: Property class 80 EN ISO 3506-1:2020 | 1.4401, 1.4404, 1.4571, 1.4578, 1.4439, 1.4362, 1.4062 acc. to EN 10088-1:2014 Corrosion resistance class CRC III acc. to EN 1993-1-4:2006+A1:2015<br>1.4565; 1.4529 acc. to EN 10088-1:2014 Corrosion resistance class CRC V acc. to EN 1993-1-4: 2006+A1:2015<br>$f_{uk}$ ≤ 1000 N/mm²; fracture elongation $A_5$ > 8 % | |

[1)] Fracture elongation $A_5$ > 8 %, for applications without requirements for seismic performance category C1 or C2

## Table A7.1: Materials, fractional sizes

| Part | Designation | Material | |
|---|---|---|---|
| 1 | Injection cartridge | Mortar, hardener, filler | |
| | Steel grade | Steel<br>zinc plated (zp, hdg) | Stainless steel R<br>Corrosion resistance class CRC III acc. to EN 1993-1-4: 2006+A1:2015 |
| 2 | Fractional Threaded rod | ASTM F568M-07, Class 5.8<br>$f_{uk}$ = 500 N/mm², $A_5$ > 12 % fracture elongation[1];<br>zinc plated ≥ 5 µm, EN ISO 4042:2022<br>ASTM F1554-20, Grade 36<br>$f_{uk}$ = 400 N/mm², $A_5$ > 12 % fracture elongation[1];<br>zinc plated ≥ 5 µm, EN ISO 4042:2022<br>ASTM F1554-20, Grade 55<br>$f_{uk}$ = 517 N/mm², $A_5$ > 12 % fracture elongation[1];<br>zinc plated ≥ 5 µm; EN ISO 4042:2022<br>ASTM F1554-20, Grade 105<br>$f_{uk}$ = 862 N/mm², $A_5$ > 12 % fracture elongation[1];<br>zinc plated ≥ 5 µm, EN ISO 4042:2022<br>ASTM A193/A193M-23, Grade B7<br>$f_{uk}$ = 862 N/mm², $A_5$ > 12 % fracture elongation[1];<br>zinc plated ≥ 5 µm, EN ISO 4042:2022 | ASTM F593M-13ae1, Alloy Group 2<br>$f_{uk}$ = 689 N/mm², $f_{uk}$, ≤ 5/8 in. (CW1)<br>$f_{uk}$ = 586 N/mm², $f_{uk}$, ≥ 3/4 in. (CW2)<br>$A_5$ > 12 % fracture elongation[1];<br>ASTM A193/A193M-23, Grade B8M, Class 1<br>$f_{uk}$ = 517 N/mm², $A_5$ > 12 % fracture elongation[1];<br>ASTM A193/A193M-23, Grade B8M, Class 2B<br>$f_{uk}$ = 655 N/mm², $A_5$ > 12 % fracture elongation[1] |
| 3 | Washer | ASTM F436/F436M-19<br>zinc plated ≥ 5 µm, EN ISO 4042:2022<br>or hot dip galvanised ≥ 40 µm<br>EN ISO 10684:2004+AC:2009 | ASTM A240/A240M-23a Type 316 |
| 4 | Hexagon nut | ASTM A563/A563M-23, Grade DH or<br>ASTM A194/A194M-23, Grade 2H<br>for Threaded rod material<br>ASTM F568M-07, Class 5.8 or<br>ASTM F1554-20, Grade 36, 55, 105<br><br>ASTM A194/A194M-23, Grade 2H / 4 / 7 for Threaded rod material<br>ASTM A193/A193M-23, B7<br>zinc plated ≥ 5 µm, EN ISO 4042:2022 | ASTM F593M-13ae1, Alloy Group 2<br>for Threaded rod material:<br>ASTM F593M-13ae1, Alloy Group 2 /<br><br>ASTM A193/A193M-23, Grade 8M<br>for Threaded rod material:<br>ASTM A193/A193M-23, Grade B8M, Class 1<br>or<br>ASTM A193/A193M-23, Grade B8M, Class 2B |
| 5 | fischer RG M I | Property class 5.8<br>EN ISO 898-1:2013<br>zinc plated ≥ 5 µm, ISO 4042:2022 | Property class 70; EN ISO 3506-1:2020;<br>1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362;<br>EN 10088-1:2014 |
| 6 | Commercial standard screw or Threaded rod for fischer RG M I | See Table A7.1, line 2,<br>steel zinc plated,<br>EN ISO 4042:2022 | See Table A7.1, line 2,<br>stainless steel R |
| 7 | fischer filling disc similar to DIN 6319-G | zinc plated ≥ 5 µm,<br>EN ISO 4042:2022<br>or hot dip galvanised ≥ 40 µm<br>EN ISO 10684:2004+AC:2009 | 1.4401; 1.4404; 1.4578;<br>1.4571; 1.4439; 1.4362;<br>EN 10088-1:2014 |
| 8 | Reinforcing bar | ASTM A615/A615M-22 (ASTM A767/A767M-19)<br>Grade 40, $f_{uk}$ = 414 N/mm², $f_{yk}$ = 276 N/mm², $A_5$ > 12 % fracture elongation[1]<br>Grade 60, $f_{uk}$ = 621 N/mm², $f_{yk}$ = 414 N/mm², $A_5$ > 12 % fracture elongation[1]<br>Grade 75, $f_{uk}$ = 689 N/mm², $f_{yk}$ = 517 N/mm², $A_5$ > 12 % fracture elongation[1]<br>Grade 60, $f_{uk}$ = 552 N/mm², $f_{yk}$ = 414 N/mm², $A_5$ > 12 % fracture elongation[1]<br>Grade 80, $f_{uk}$ = 689 N/mm², $f_{yk}$ = 552 N/mm², $A_5$ > 12 % fracture elongation[1] | |

[1] Fracture elongation $A_5$ > 8 %, for applications without requirements for seismic performance category C1 or C2

## Specifications of intended use part 1

**Table B1.1:** Overview use and performance categories

| Anchorages subject to | | | FIS EM Plus with … | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Anchor rod / Threaded rod | | fischer RG M I | | Reinforcing bar | | fischer FRA | |
| Hammer drilling with standard drill bit | | | all sizes | | | | | | | |
| Hammer drilling with hollow drill bit | | | Nominal drill bit diameter ($d_0$)<br>12 mm to 35 mm; 7/16" to 1 3/8"<br>(fischer "FHD", Heller "Duster Expert"; Bosch „Speed Clean"; Hilti "TE-CD, TE-YD",DreBo „D-Plus", DreBo „D-Max") | | | | | | | |
| Diamond drilling | | | all sizes | | | | | | | |
| Static and quasi static load, in uncracked / cracked concrete | | Metric sizes | M8 to M30 | Annexes: C1, C4 – C6, C17 | M8 to M20 | Annexes: C2, C4, C7, C8, C17 | ϕ8 to ϕ40 | Annexes: C3, C4, C9 – C13 C18 | M12 to M24 | Annexes: C3, C4, C14 – C16, C18 |
| | | Fractional sizes | 3/8" to 1 1/8" | Annexes: C19, C20, C24 – C28, C35 | 3/8" to 3/4" | Annexes: C21, C22, C24, C29 – C31, C35 | #3 to #10 | Annexes: C23, C24, C32 – C34, C36 | -[1] | |
| Seismic performance category (only hammer drilling with standard / hollow drill bits) | | C1 | M10 to M30 | Annexes: C37, C39, C40 | -[1] | | ϕ10 to ϕ32 | Annexes: C38, C39, C41 | -[1] | |
| | | | 3/8" to 1 1/8" | Annexes: C43, C45, C46 | | | #3 to #10 | Annexes: C44, C45, C47 | | |
| | | C2 | M12 M16 M20 M24 | Annexes: C38, C39, C42 | | | -[1] | | | |
| Use category | I1 | dry or wet concrete | all sizes | | | | | | | |
| | I2 | water filled hole | all sizes<br>(not permitted for diamond drilling in combination with cracked concrete and working life 100 years) | | | | | | | |
| Installation direction | | | D3 (downward and horizontal and upwards (e.g. overhead) installation) | | | | | | | |
| Installation temperature | | | $T_{i,min}$ = -5 °C to $T_{i,max}$ = +40 °C<br>for the standard variation of temperature after installation | | | | | | | |
| Resistance to fire | | | Annexes: C48 – C51 | | -[1] | | -[1] | | -[1] | |
| In-service temperature | | Temperature range I | -40 °C to +40 °C | (max. short term temperature +40 °C; max. long term temperature +24 °C) | | | | | | |
| | | Temperature range II | -40 °C to +60 °C | (max. short term temperature +60 °C; max. long term temperature +35 °C) | | | | | | |
| | | Temperature range III | -40 °C to +72 °C | (max. short term temperature +72 °C; max. long term temperature +50 °C) | | | | | | |

[1] no performance assessed.

## Specifications of intended use part 2

**Base materials:**

- Compacted reinforced or unreinforced normal weight concrete without fibres of strength classes C20/25 to C50/60 according to EN 206:2013+A2:2021.

**Use conditions (Environmental conditions):**

- Fastener intended for use in structures subject to dry, internal conditions (all materials).
- For all other conditions according to EN 1993-1-4:2006+A1:2015 corresponding to corrosion resistance classes to Annex A6 table A6.1 (metric sizes) or Annex A7 table A7.1 (fractional sizes).

**Design:**

- Fastenings are designed under the responsibility of an engineer experienced in fastenings and concrete work.
- Verifiable calculation notes and drawings are to be prepared taking account of the loads to be anchored. The position of the fastener is indicated on the design drawings (e. g. position of the fastener relative to reinforcement or to supports, etc.).
- Fastenings are designed in accordance with:
  EN 1992-4:2018 and TR 082 from June 2023.

**Installation:**

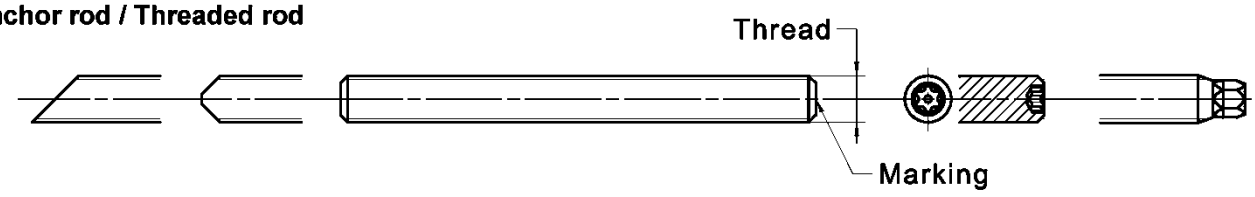
- Fastener installation is to be carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.
- Fastening depth should be marked and adhered to installation.
- Overhead installation is allowed (necessary equipment see installation instruction).

**Table B3.1:** Installation parameters for **metric Anchor rods / Threaded rods**

| **Anchor rods / Threaded rods** | | | | **M8** | **M10** | **M12** | **M14** | **M16** | **M20** | **M22** | **M24** | **M27** | **M30** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal drill hole diameter | | $d_0$ | [mm] | 10 | 12 | 14 | 16 | 18 | 22<br>24[1)] | 25 | 28 | 30 | 35 |
| Drill hole depth | | $h_0$ | | $h_0 \geq h_{ef}$ | | | | | | | | | |
| Effective embedment depth | | $h_{ef,\,min}$ | | 60 | 60 | 70 | 75 | 80 | 90 | 93 | 96 | 108 | 120 |
| | | $h_{ef,\,max}$ | | 160 | 200 | 240 | 280 | 320 | 400 | 440 | 480 | 540 | 600 |
| Diameter of the clearance hole of the fixture | pre-positioned installation | $d_f$ | | 9 | 12 | 14 | 16 | 18 | 22 | 24 | 26 | 30 | 33 |
| | push through installation | $d_f$ | | 12 | 14 | 16 | 18 | 20 | 26 | 28 | 30 | 33 | 40 |
| Minimum thickness of concrete member | | $h_{min}$ | | $h_{ef} + 30$ | | | $h_{ef} + 2d_0$ | | | | | | |
| Maximum installation torque | | max $T_{inst}$ | [Nm] | 10 | 20 | 40 | 50 | 60 | 120 | 135 | 150 | 200 | 300 |

[1)] Both drill hole diameters can be used.

**Anchor rod / Threaded rod**



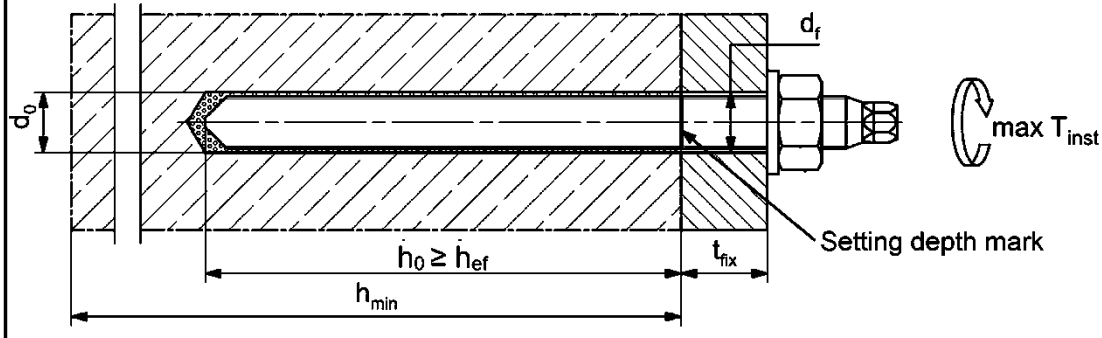

**Marking (on random place) anchor rod:**

| | | | |
|---|---|---|---|
| Steel zinc plated PC[1)] 8.8 | • or + | Steel hot-dip PC[1)] 8.8 | • |
| High corrosion resistant steel HCR PC[1)] 50 | • | High corrosion resistant steel HCR PC[1)] 70 | - |
| High corrosion resistant steel HCR PC[1)] 80 | ( | Stainless steel R property class 50 | ~ |
| Stainless steel R property class 80 | * | | |

Alternatively: Colour coding according to DIN 976-1:2016

[1)] PC = property class

**Installation conditions:**




**Threaded rods, washers and hexagon nuts may also be used if the following requirements are fulfilled**

- Materials, dimensions and mechanical properties according to **Annex A6**, **Table A6.1**.
- Inspection certificate 3.1 according to EN 10204:2004, the documents have to be stored.
- Setting depth is marked.

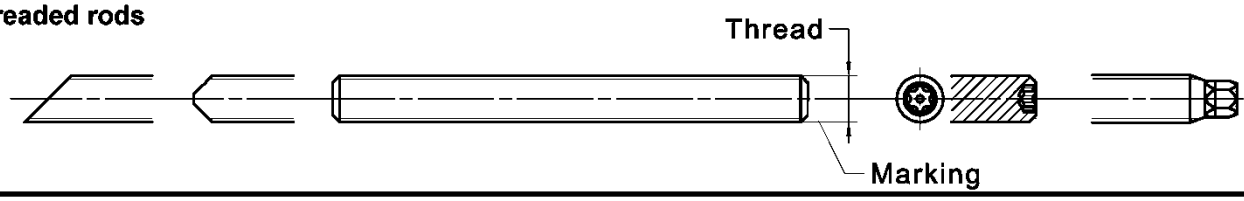
Figures not to scale

**Table B4.1:** Installation parameters for **fractional Threaded rods**

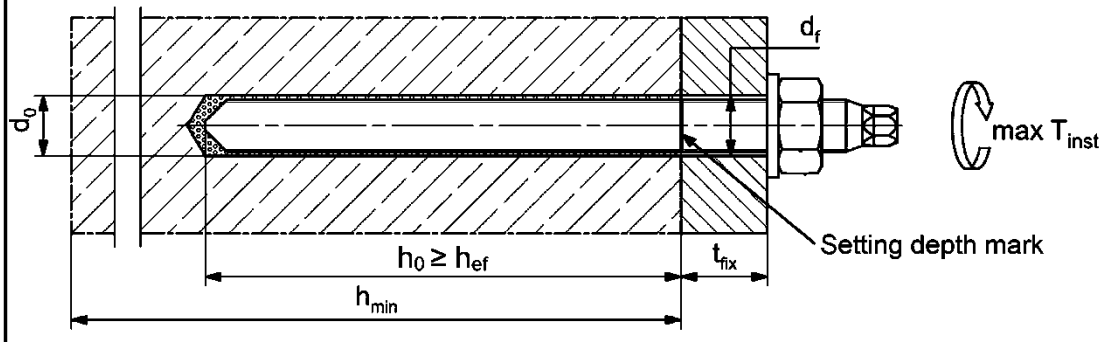
| **Threaded rods** | | | | **3/8"** | **1/2"** | **5/8"** | **3/4"** | **7/8"** | **1"** | **1 1/8"** |
|---|---|---|---|---|---|---|---|---|---|---|
| Nominal drill hole diameter | | $d_0$ | [mm] | 11,1 | 14,3 | 19,1 | 22,2 | 25,4 | 28,6 | 31,8 |
| | | | [inch] | 7/16 | 9/16 | 3/4 | 7/8 | 1 | 1 1/8 | 1 1/4 |
| Drill hole depth | | $h_0$ | | $h_0 \geq h_{ef}$ | | | | | | |
| Effective embedment depth | | $h_{ef,\,min}$ | | 60,0 | 70,0 | 79,0 | 89,0 | 89,0 | 102,0 | 178,0 |
| | | $h_{ef,\,max}$ | | 191,0 | 254,0 | 318,0 | 381,0 | 445,0 | 508,0 | 572,0 |
| Diameter of the clearance hole of the fixture | pre-positioned installation | $d_f$ | [mm] | 8,9 | 11,9 | 14,0 | 16,0 | 18,0 | 22,1 | 23,9 |
| | push through installation | $d_f$ | | 11,9 | 14,0 | 16,0 | 18,0 | 20,1 | 25,9 | 27,9 |
| Minimum thickness of concrete member | | $h_{min}$ | | $h_{ef} + 30$ | | $h_{ef} + 2d_0$ | | | | |
| Maximum installation torque | | max $T_{inst}$ | [Nm] | 18 | 41 | 60 | 107 | 136 | 173 | 180 |

[1] Both drill hole diameters can be used.

**Threaded rods**




**Installation conditions:**




**Additional requirements for Threaded rods, washers and hexagon nuts:**

- Materials, dimensions, and mechanical properties according to **Annex A7**, **Table A7.1**.
- Inspection certificate 3.1 according to EN 10204:2004, the documents shall be stored.
- Setting depth is marked.

Figures not to scale

**Table B5.1:** Minimum spacing and minimum edge distance for **metric Anchor rods** and **metric reinforcing bars**

| **Metric Anchor rods** | | | **M8** | **M10** | **M12** | **M14** | **M16** | **-** | **M20** | **M22** | **M24** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Metric Reinforcing bars (nominal diameter)** | | **ϕ** | **8** | **10** | **12** | **14** | **16** | **18** | **20** | **22** | **24** |
| **Minimum edge distance** | | | | | | | | | | | |
| Uncracked / cracked concrete | $c_{min}$ | [mm] | 40 | 45 | 45 | 45 | 50 | 55 | 55 | 55 | 60 |
| Minimum spacing | $s_{min}$ | | according to Annex B7 | | | | | | | | |
| **Minimum spacing** | | | | | | | | | | | |
| Uncracked / cracked concrete | $s_{min}$ | [mm] | 40 | 45 | 55 | 60 | 65 | 85 | 85 | 95 | 105 |
| Minimum edge distance | $c_{min}$ | | according to Annex B7 | | | | | | | | |
| **Required projecting area** | | | | | | | | | | | |
| Uncracked concrete | $A_{sp,req}$ | [1000 mm²] | 8 | 13 | 21,5 | 23 | 24 | 38,5 | 38,5 | 39,5 | 40 |
| Cracked concrete | | | 6,5 | 10 | 16,5 | 17,5 | 18,5 | 29,5 | 29,5 | 30 | 30,5 |

| **Anchor rods** | | | **-** | **-** | **M27** | **-** | **M30** | **-** | **-** | **-** | **-** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Reinforcing bars (nominal diameter)** | | **ϕ** | **25** | **26** | **-** | **28** | **30** | **32** | **34** | **36** | **40** |
| **Minimum edge distance** | | | | | | | | | | | |
| Uncracked / cracked concrete | $c_{min}$ | [mm] | 75 | 75 | 75 | 80 | 80 | 120 | 120 | 135 | 175 |
| Minimum spacing | $s_{min}$ | | according to Annex B7 | | | | | | | | |
| **Minimum spacing** | | | | | | | | | | | |
| Uncracked / cracked concrete | $s_{min}$ | [mm] | 120 | 120 | 120 | 140 | 140 | 160 | 160 | 160 | 160 |
| Minimum edge distance | $c_{min}$ | | according to Annex B7 | | | | | | | | |
| **Required projecting area** | | | | | | | | | | | |
| Uncracked concrete | $A_{sp,req}$ | [1000 mm²] | 47,5 | 47,5 | 47,5 | 64 | 64 | 64 | 64 | 64 | 64 |
| Cracked concrete | | | 36,5 | 36,5 | 36,5 | 49 | 49 | 49 | 49 | 49 | 49 |

**Splitting failure** for minimum edge distance and spacing in dependence of the effective embedment depth $h_{ef}$.

For the calculation of minimum spacing and minimum edge distance of anchors in combination with different embedment depths and thicknesses of concrete members the following equation shall be fulfilled:

$$\mathbf{A_{sp,req} < A_{sp,t}}$$

$A_{sp,req}$ = required projecting area
$A_{sp,t}$ = effective projecting area (according to **Annex B7**)

**Table B6.1:** Minimum spacing and minimum edge distance for **fractional Threaded rods** and **reinforcing bars**

| **Fractional Threaded rods** | | | **3/8"** | **1/2"** | **5/8"** | **3/4"** | **7/8"** | **1"** | **1 1/8"** | **-** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Fractional Reinforcing bars** | | | **#3** | **#4** | **#5** | **#6** | **#7** | **#8** | **#9** | **#10** |
| **Minimum edge distance** | | | | | | | | | | |
| Uncracked / cracked concrete | $c_{min}$ | [mm] | 45 | 45 | 50 | 55 | 60 | 75 | 80 | 120 |
| Minimum spacing | $s_{min}$ | | according to Annex B7 | | | | | | | |
| **Minimum spacing** | | | | | | | | | | |
| Uncracked / cracked concrete | $s_{min}$ | [mm] | 45 | 60 | 65 | 85 | 105 | 120 | 140 | 160 |
| Minimum edge distance | $c_{min}$ | | according to Annex B7 | | | | | | | |
| **Required projecting area** | | | | | | | | | | |
| Uncracked concrete | $A_{sp,req}$ | [1000 mm²] | 12,5 | 21,0 | 24,5 | 36,0 | 39,5 | 43,5 | 40,5 | 64,5 |
| Cracked concrete | | | 9,5 | 16,0 | 18,5 | 27,5 | 30,0 | 33,5 | 31,0 | 49,5 |

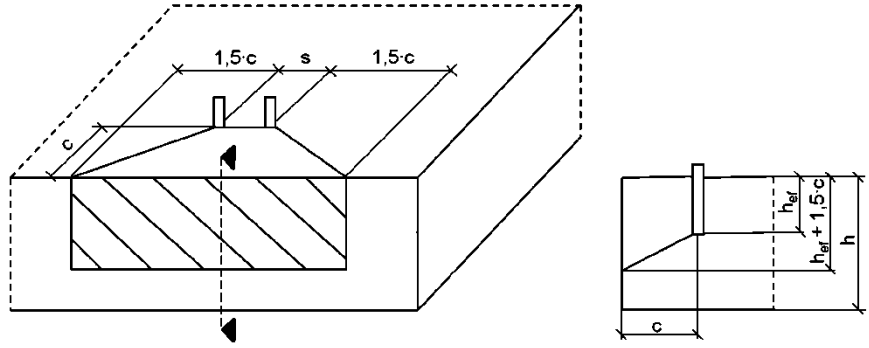
**Splitting failure** for minimum edge distance and spacing in dependence of the effective embedment depth $h_{ef}$.

For the calculation of minimum spacing and minimum edge distance of anchors in combination with different embedment depths and thicknesses of concrete members the following equation shall be fulfilled:

$$\mathbf{A_{sp,req} < A_{sp,t}}$$

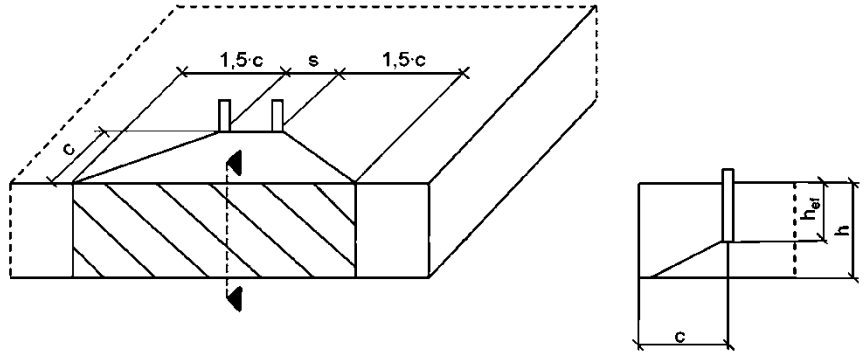
$A_{sp,req}$ = required projecting area
$A_{sp,t}$ = effective projecting area (according to **Annex B7**)

**Table B7.1:** **Projecting area $A_{sp,t}$** with concrete member thickness $h > h_{ef} + 1{,}5 \cdot c$ and $h \geq h_{min}$




| | | | |
|---|---|---|---|
| Single fastener | $A_{sp,t} = (3 \cdot c) \cdot (h_{ef} + 1{,}5 \cdot c)$ | [mm²] | with $c \geq c_{min}$ |
| Group of fastener with $s > 3 \cdot c$ | $A_{sp,t} = (6 \cdot c) \cdot (h_{ef} + 1{,}5 \cdot c)$ | [mm²] | |
| Group of fastener with $s \leq 3 \cdot c$ | $A_{sp,t} = (3 \cdot c + s) \cdot (h_{ef} + 1{,}5 \cdot c)$ | [mm²] | with $c \geq c_{min}$ and $s \geq s_{min}$ |

**Table B7.2:** **Projecting area $A_{sp,t}$** with concrete member thickness $h \leq h_{ef} + 1{,}5 \cdot c$ and $h \geq h_{min}$




| | | | |
|---|---|---|---|
| Single anchor | $A_{sp,t} = 3 \cdot c \cdot$ existing h | [mm²] | with $c \geq c_{min}$ |
| Group of fastener with $s > 3 \cdot c$ | $A_{sp,t} = 6 \cdot c \cdot$ existing h | [mm²] | |
| Group of fastener with $s \leq 3 \cdot c$ | $A_{sp,t} = (3 \cdot c + s) \cdot$ existing h | [mm²] | with $c \geq c_{min}$ and $s \geq s_{min}$ |

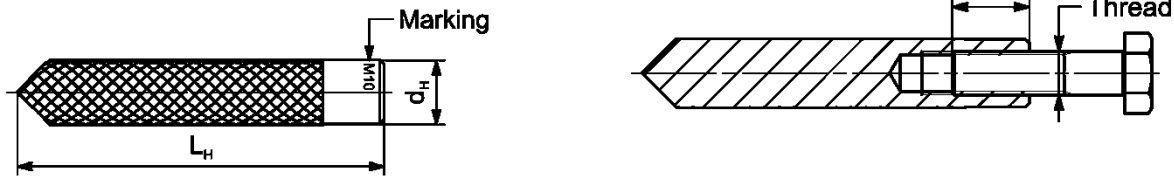
Edge distance and axial spacing shall be rounded up to at least 5 mm.

Figures not to scale

**Table B8.1:** Installation parameters for **metric fischer RG M I**

| **fischer RG M I** | | **Thread** | **M8** | **M10** | **M12** | **M16** | **M20** |
|---|---|---|---|---|---|---|---|
| Diameter of anchor | $d_{nom} = d_H$ | | 12 | 15,7 | 18 | 22 | 28 |
| Nominal drill hole diameter | $d_0$ | | 14 | 18 | 20 | 24 | 32 |
| Drill hole depth | $h_0$ | | $h_0 \geq h_{ef} = L_H$ | | | | |
| Effective embedment depth ($h_{ef} = L_H$) | $h_{ef}$ | | 90 | 90 | 125 | 160 | 200 |
| Minimum spacing and minimum edge distance | $s_{min}$ = $c_{min}$ | [mm] | 55 | 65 | 75 | 95 | 125 |
| Diameter of clearance hole in the fixture | $d_f$ | | 9 | 12 | 14 | 18 | 22 |
| Minimum thickness of concrete member | $h_{min}$ | | 120 | 125 | 165 | 205 | 260 |
| Maximum screw-in depth | $l_{E,max}$ | | 18 | 23 | 26 | 35 | 45 |
| Minimum screw-in depth | $l_{E,min}$ | | 8 | 10 | 12 | 16 | 20 |
| Maximum installation torque | max $T_{inst}$ | [Nm] | 10 | 20 | 40 | 80 | 120 |

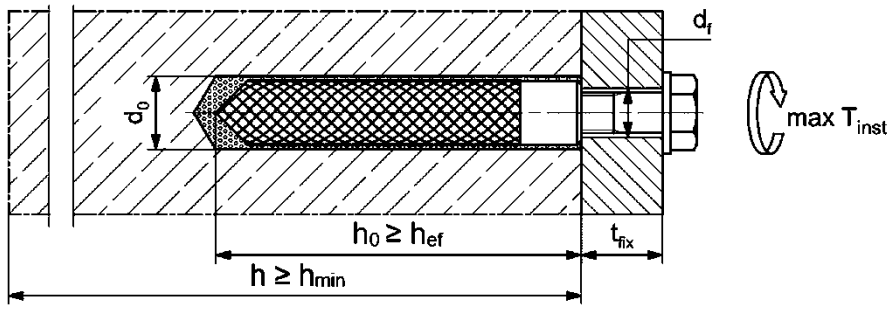
**fischer RG M I**




**Marking:** Anchor size e. g.: **M10**
Stainless steel → additional **R**; e.g.: **M10 R**
High corrosion resistant steel → additional **HCR**; e.g.: **M10 HCR**

Retaining screw or threaded rods (including nut and washer) must comply with the appropriate material and strength class of **Annex A6**, **Table A6.1**.

**Installation conditions:**




Figures not to scale

fischer injection system FIS EM Plus

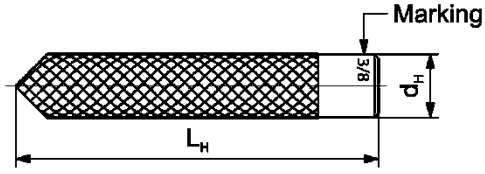
**Intended use**
Installation parameters internal threaded anchors RG M I (metric size)

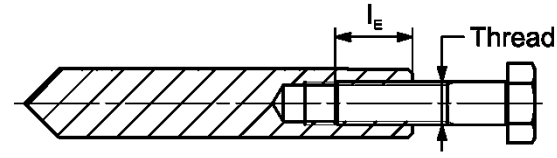
**Annex B8**

**Table B9.1:** Installation parameters for **fractional fischer RG M I**

| **fischer RG M I** | | **Thread** | **3/8"** | **1/2"** | **5/8"** | **3/4"** |
|---|---|---|---|---|---|---|
| Diameter of anchor | $d_{nom} = d_H$ | [mm] | 15,7 | 18 | 22 | 28 |
| Nominal drill hole diameter | $d_0$ | [mm] | 18 | 20 | 24 | 32 |
| | | [inch] | 3/4 | 13/16 | 1 | 1 1/4 |
| Drill hole depth | $h_0$ | [mm] | $h_0 \geq h_{ef} = L_H$ | | | |
| Effective embedment depth ($h_{ef} = L_H$) | $h_{ef}$ | | 90 | 125 | 160 | 200 |
| Minimum spacing and minimum edge distance | $s_{min}$ = $c_{min}$ | | 65 | 75 | 95 | 125 |
| Diameter of clearance hole in the fixture | $d_f$ | | 12 | 14 | 18 | 22 |
| Minimum thickness of concrete member | $h_{min}$ | | 125 | 165 | 205 | 260 |
| Maximum screw-in depth | $l_{E,max}$ | | 23 | 26 | 35 | 45 |
| Minimum screw-in depth | $l_{E,min}$ | | 10 | 12 | 16 | 20 |
| Maximum installation torque | max $T_{inst}$ | [Nm] | 20 | 40 | 80 | 120 |

**fischer RG M I**

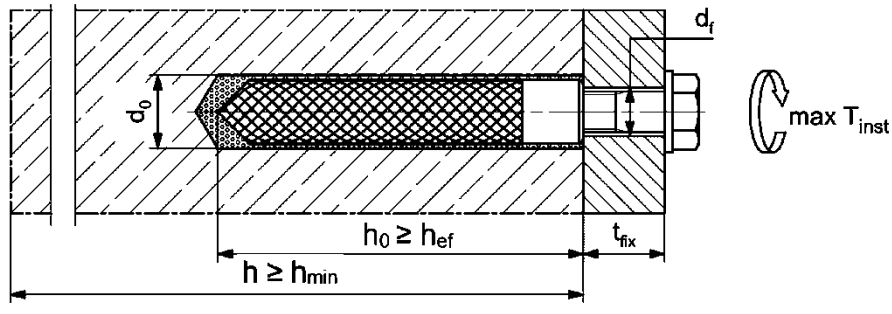



**Marking:** Anchor size e. g.: **M 3/8**
Stainless steel → additional **R**; e.g.: **M 3/8 R**

Retaining screw or threaded rods (including nut and washer) must comply with the appropriate material and strength class of **Annex A7**, **Table A7.1**.

**Installation conditions:**




Figures not to scale

fischer injection system FIS EM Plus

**Intended use**
Installation parameters internal threaded anchors RG M I (fractional size)

**Annex B9**

**Table B10.1:** Installation parameters for **metric reinforcing bars** [1)]

| **Nominal diameter of the bar** | | **ϕ** | **8**[2)] | **10**[2)] | **12**[2)] | **14** | **16** | **18** | **20** | **22** | **24** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal drill hole diameter | $d_0$ | [mm] | 10 \| 12 | 12 \| 14 | 14 \| 16 | 18 | 20 | 25 | 25 | 30 | 30 |
| Drill hole depth | $h_0$ | | $h_0 \geq h_{ef}$ | | | | | | | | |
| Effective embedment depth | $h_{ef,min}$ | | 60 | 60 | 70 | 75 | 80 | 85 | 90 | 94 | 98 |
| | $h_{ef,max}$ | | 160 | 200 | 240 | 280 | 320 | 360 | 400 | 440 | 480 |
| Minimum thickness of concrete member | $h_{min}$ | | $h_{ef} + 30$ | | | $h_{ef} + 2d_0$ | | | | | |

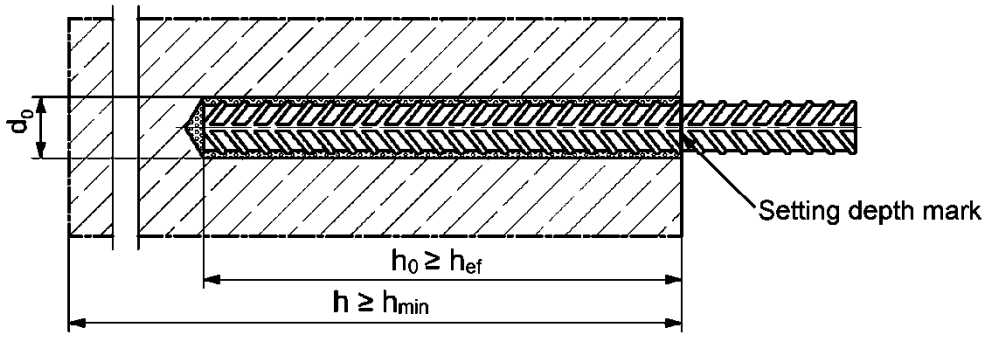
| **Nominal diameter of the bar** | | **ϕ** | **25** | **26** | **28** | **30** | **32** | **34** | **36** | **40** | **-** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal drill hole diameter | $d_0$ | [mm] | 30 | 35 | 35 | 40 | 40 | 40 | 45 | 55 | - |
| Drill hole depth | $h_0$ | | $h_0 \geq h_{ef}$ | | | | | | | | |
| Effective embedment depth | $h_{ef,min}$ | | 100 | 104 | 112 | 120 | 128 | 136 | 144 | 160 | - |
| | $h_{ef,max}$ | | 500 | 520 | 560 | 600 | 640 | 680 | 720 | 800 | - |
| Minimum thickness of concrete member | $h_{min}$ | | $h_{ef} + 2d_0$ | | | | | | | | |

[1)] Detailed calculation according to **Annex B7**.
[2)] Both drill hole diameters can be used.

**Reinforcing bar**

- The minimum value of related rib area $f_{R,min}$ must fulfil the requirements of EN 1992-1-1:2004+AC:2010
- The rib height must be within the range: $0,05 \cdot \phi \leq h_{rib} \leq 0,07 \cdot \phi$
  ($\phi$ = Nominal diameter of the bar, $h_{rib}$ = rib height)

**Installation conditions:**




Figures not to scale

fischer injection system FIS EM Plus

**Intended use**
Installation parameters reinforcing bars (metric size)

**Annex B10**

**Table B11.1:** Installation parameters for **fractional reinforcing bars** [1)]

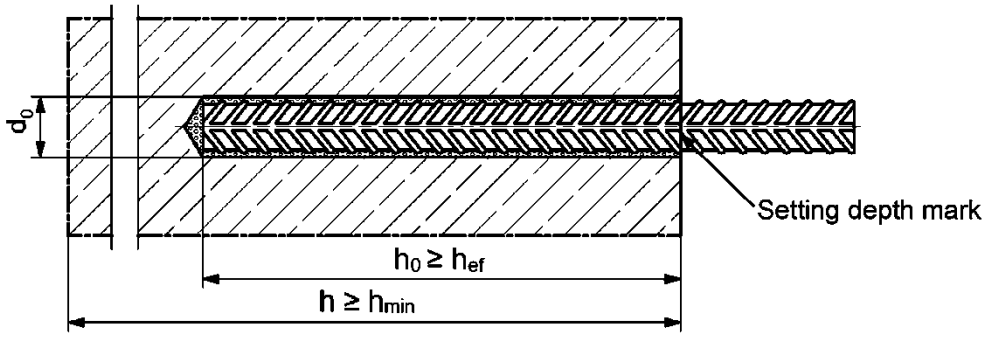
| **Rebar size** | | | **#3** | **#4** | **#5** | **#6** | **#7** | **#8** | **#9** | **#10** |
|---|---|---|---|---|---|---|---|---|---|---|
| Nominal drill hole diameter | $d_0$ | [mm] | 12,7 | 15,9 | 19,1 | 22,2 | 28,6 | 31,8 | 34,9 | 38,1 |
| | | [inch] | 1/2 | 5/8 | 3/4 | 7/8 | 1 1/8 | 1 1/4 | 1 3/8 | 1 1/2 |
| Drill hole depth | $h_0$ | [mm] | $h_0 \geq h_{ef}$ | | | | | | | |
| Effective embedment depth | $h_{ef,min}$ | | 60 | 70 | 79 | 89 | 89 | 102 | 114 | 127 |
| | $h_{ef,max}$ | | 191 | 254 | 318 | 381 | 445 | 508 | 572 | 635 |
| Minimum thickness of concrete member | $h_{min}$ | | $h_{ef}$ + 30 | | $h_{ef}$ + 2$d_0$ | | | | | |

[1)] Detailed calculation according to **Annex B7**.

**Reinforcing bar**

- Reinforcing bars, acc. to ASTM A615/A615M-22 (ASTM A767/A767M-19).
  Materials, dimensions, and mechanical properties according to **Annex A7**, **Table A7.1**.

**Installation conditions:**




Figures not to scale

fischer injection system FIS EM Plus

**Intended use**
Installation parameters reinforcing bars (fractional size)

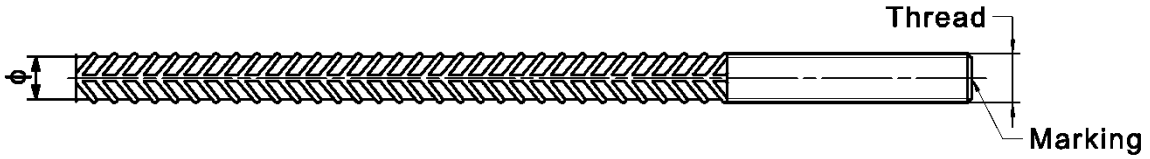
**Annex B11**

**Table B12.1:** Installation parameters for **metric fischer FRA**

| **fischer FRA** | | **Thread** | **M12**[1] | **M16** | **M20** | **M24** |
|---|---|---|---|---|---|---|
| Nominal diameter of the bar | $\phi$ | | 12 | 16 | 20 | 25 |
| Nominal drill hole diameter | $d_0$ | | 14 / 16 | 20 | 25 | 30 |
| Drill hole depth | $h_0$ | | $h_{ef} + l_e = h_{nom}$ | | | |
| Effective embedment depth | $h_{ef,min}$ | | 70 | 80 | 90 | 96 |
| | $h_{ef,max}$ | | 140 | 220 | 300 | 380 |
| Distance concrete surface to welded joint | $l_e$ | | 100 | | | |
| Minimum spacing and minimum edge distance | $s_{min}$ = $c_{min}$ | [mm] | 55 | 65 | 85 | 105 |
| Diameter of clearance hole in the fixture – pre-positioned anchorage | $\leq d_f$ | | 14 | 18 | 22 | 26 |
| Diameter of clearance hole in the fixture – push through anchorage | $\leq d_f$ | | 18 | 22 | 26 | 32 |
| Minimum thickness of concrete member | $h_{min}$ | | $h_0 + 30$ | $h_0 + 2d_0$ | | |
| Maximum installation torque | max $T_{inst}$ | [Nm] | 40 | 60 | 120 | 150 |

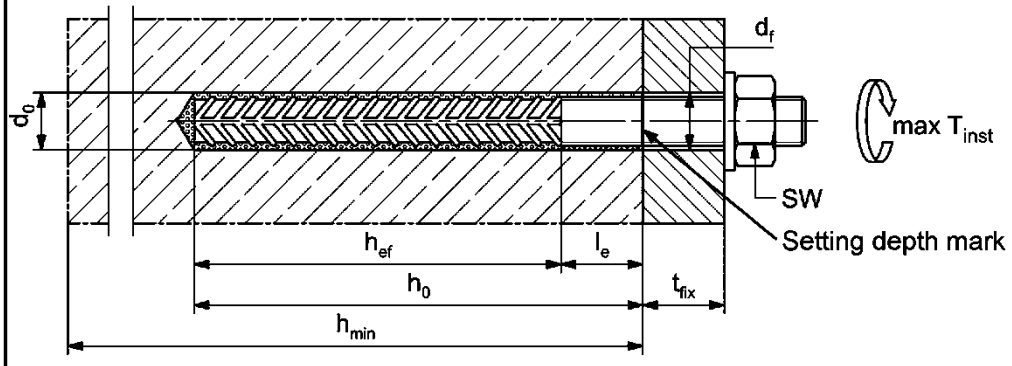
[1] Both drill hole diameters can be used.

**fischer FRA**




Marking frontal e.g.: FRA (for stainless steel R)
FRA HCR (for high corrosion resistant steel HCR)

**Installation conditions:**




Figures not to scale

fischer injection system FIS EM Plus

**Intended use**
Installation parameters fischer FRA (metric size)

**Annex B12**

**Table B13.1:** Parameters of the **cleaning brush BS / BSB** (steel brush with steel bristles)

The size of the cleaning brush refers to the drill hole diameter.

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal drill hole diameter $d_0$ | [mm] | 10 | 12 | 14 | 16 | 18 | 20 | 24 | 25 | 28 | 30 | 32 | 35 | 40 | 45 | 55 |
| | [inch] | - | 7/16 | 1/2 | 5/8 | 3/4 | 13/16 | 1 | | 1 1/8 | 1 1/4 | | 1 3/8 | 1 1/2 | - | - |
| Steel brush diameter BS $d_b$ | [mm] | 11 | 14 | 16 | 20 | | 25 | 26 | 27 | 30 | 40 | | | - | - | - |
| Steel brush diameter BSB $d_b$ | [mm] | - | - | - | - | | - | - | - | - | - | | | 42 | 47 | 58 |

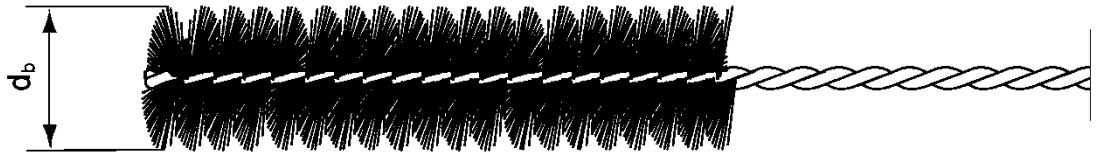



**Table B13.2:** Conditions for use **static mixer** without an **extension tube**

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal drill hole diameter $d_0$ | | [mm] | 10 | 12 | 14 | 16 | 18 | 20 | 24 | 25 | 28 | 30 | 32 | 35 | 40 | 45 | 55 |
| | | [inch] | – | 7/16 | 1/2 | 5/8 | 3/4 | 13/16 | 1 | | 1 1/8 | 1 1/4 | | 1 3/8 | 1 1/2 | - | - |
| Drill hole depth $h_0$ by using | FIS MR Plus | [mm] | ≤ 90 | | ≤ 120 | ≤ 140 | ≤ 150 | ≤ 160 | ≤ 190 | ≤ 210 | | | | | | | |
| | FIS UMR | [mm] | - | | ≤ 90 | ≤ 160 | ≤ 180 | ≤ 190 | ≤ 220 | ≤ 250 | | | | | | | |

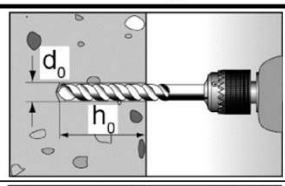
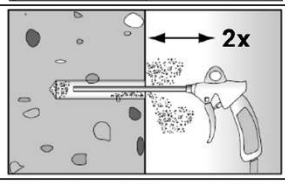
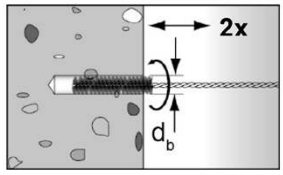
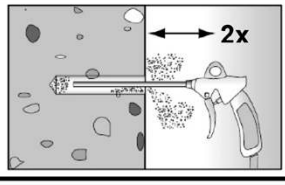
**Table B13.3:** **Maximum processing time** of the mortar and **minimum curing time** (During the curing time of the mortar the concrete temperature may not fall below the listed minimum temperature)

| Temperature at anchoring base [°C] | Maximum processing time $t_{work}$ | Minimum curing time [1] $t_{cure}$ |
|---|---|---|
| -5 to 0 [2] | 240 min | 200 h |
| > 0 to 5 [2] | 150 min | 90 h |
| > 5 to 10 | 120 min | 40 h |
| > 10 to 20 | 30 min | 18 h |
| > 20 to 30 | 14 min | 10 h |
| > 30 to 40 | 7 min | 5 h |

[1] In wet concrete or water filled holes the curing times must be doubled.
[2] Minimal cartridge temperature +5 °C.

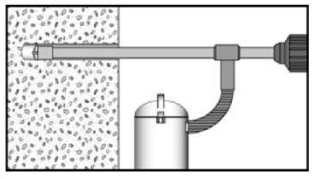
## Installation instructions part 1

### Drilling and cleaning the hole (hammer drilling with standard drill bit)

| | | |
|---|---|---|
| **1** |  | Drill the hole.<br>Nominal drill hole diameter $\mathbf{d_0}$ and drill hole depth $\mathbf{h_0}$<br>see **Tables B3.1, B4.1, B8.1, B9.1, B10.1, B11.1, B12.1**. |
| **2** |  | Cleaning the drill hole:<br>Blow out the drill hole twice, with oil free compressed air ($p \geq 6$ bar).<br>  |
| **3** |  | Brush the drill hole twice. For drill hole diameter ≥ 30 mm use a power drill.<br>For deep holes use an extension. Corresponding brushes see **Table B13.1**. |
| **4** |  | Cleaning the drill hole:<br>Blow out the drill hole twice, with oil free compressed air ($p \geq 6$ bar).<br>  |

Go to step 6

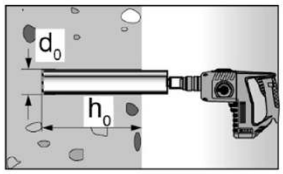
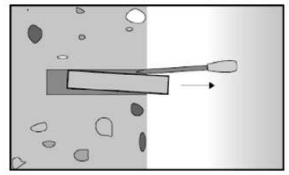
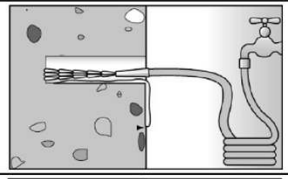
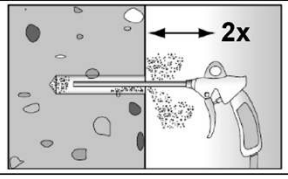
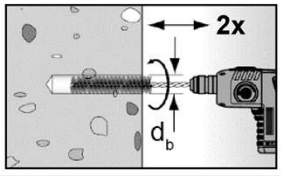
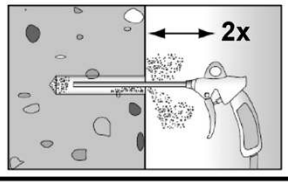
### Drilling and cleaning the hole (hammer drilling with hollow drill bit)

| | | |
|---|---|---|
| **1** |  | Check a suitable hollow drill (see **Table B1.1**)<br>for correct operation of the dust extraction. |
| **2** |  | Use a suitable dust extraction system, e. g.<br>fischer FVC 35 M or a comparable dust extraction system<br>with equivalent performance data.<br><br>Drill the hole with hollow drill bit. The dust extraction system has to extract the drill dust nonstop during the drilling process and must be adjusted to maximum power. Nominal drill hole diameter $\mathbf{d_0}$ and drill hole depth $\mathbf{h_0}$<br>see **Tables B3.1, B4.1, B8.1, B9.1, B10.1, B11.1, B12.1**. |

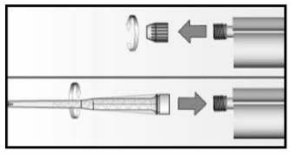
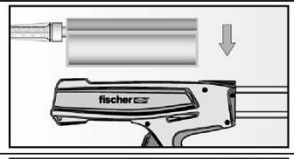
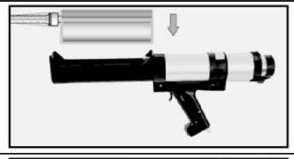
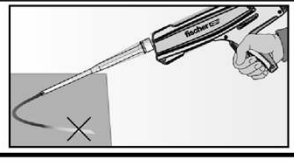
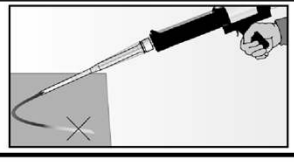
Go to step 6

## Installation instructions part 2

### Drilling and cleaning the hole (wet drilling with diamond drill bit)

| | | | | |
|---|---|---|---|---|
| 1 |  | Drill the hole.<br>Drill hole diameter $\mathbf{d_0}$ and nominal drill hole depth $\mathbf{h_0}$ see **Tables B3.1, B4.1, B8.1, B9.1, B10.1, B11.1, B12.1**. |  | Break the drill core and remove it |
| 2 |  | Flush the drill hole with clean water until it flows clear | | |
| 3 |  | Blow out the drill hole twice, using oil-free compressed air (p > 6 bar) | | |
| 4 |  | Brush the drill hole twice using a power drill.<br>Corresponding brushes see **Table B13.1** | | |
| 5 |  | Blow out the drill hole twice, using oil-free compressed air (p > 6 bar) | | |

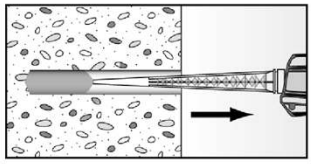
### Preparing the cartridge

| | | | | |
|---|---|---|---|---|
| 6 |  | Remove the sealing cap<br>Screw on the static mixer<br>(the spiral in the static mixer must be clearly visible) | | |
| 7 |  | |  | Place the cartridge into the dispenser. |
| 8 |  | |  | Extrude approximately 10 cm of material out until the resin is evenly grey in colour. Do not use mortar that is not uniformly grey. |

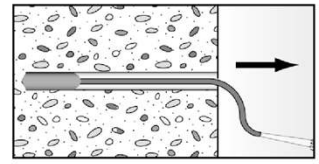
## Installation instructions part 3

Injection of the mortar

**9**

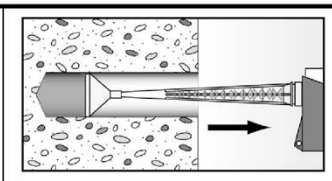


Fill approximately 2/3 of the drill hole with mortar. Always begin from the bottom of the hole and avoid bubbles.



The conditions for mortar injection without extension tube can be found in **Table B13.2**

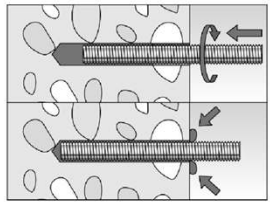
For deeper drill holes, than those mentioned in **Table B13.2,** use a suitable extension tube.

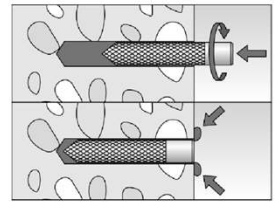


For overhead installation, deep holes ($h_0$ > 250 mm) or drill hole diameter ($d_0$ ≥ 30 mm / 1 1/8") use an injection-adapter.

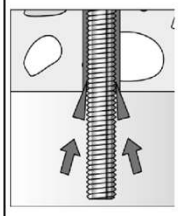
Installation of Anchor rods, threaded rods or fischer internal threaded anchors RG M I

**10**

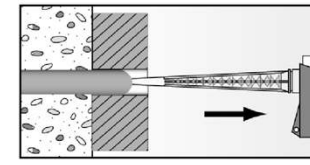




Only use clean and oil-free metal parts.
Mark the setting depth of the metal parts. Push the anchor rod, threaded rod or fischer RG M I anchor down to the bottom of the hole, turning it slightly while doing so.
After inserting the metal part, excess mortar must be emerged around the anchor element. If not, pull out the metal part immediately and reinject mortar.



For overhead installations support the metal part with wedges (e.g., fischer centering wedges) or fischer overhead clips.

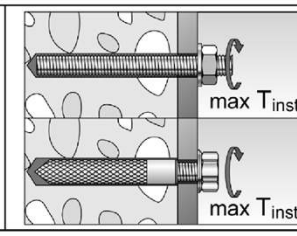


For push through installation fill the annular gap with mortar.

**11**

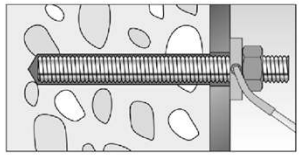
Wait for the specified curing time $t_{cure}$ see **Table B13.3**.

**12**




Mounting the fixture max $T_{inst}$ see **Tables B3.1, B4.1, B8.1 and B9.1.**

**Option**

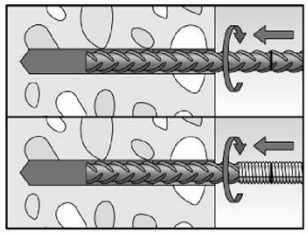


After the minimum curing time is reached, the gap between metal part and fixture (annular clearance) may be filled with mortar via the fischer filling disc.
Compressive strength ≥ 50 N/mm² (e.g., fischer injection mortars FIS EM Plus, FIS HB, FIS SB, FIS V Plus)
ATTENTION: Using fischer filling disc reduces $t_{fix}$ (usable length of the anchor).

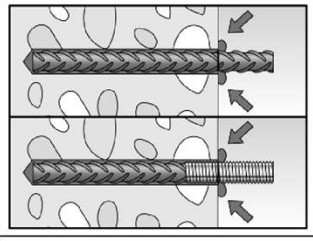
## Installation instructions part 4

Installation reinforcing bars and fischer FRA

**10**



Only use clean and oil-free reinforcing bars or fischer FRA. Mark the setting depth. Turn while using force to push the reinforcement bar or the fischer FRA into the filled hole up to the setting depth mark.

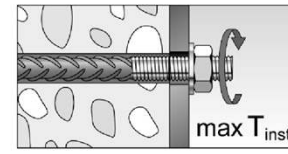


When the setting depth mark is reached, excess mortar must be emerged from the mouth of the drill hole. If not, pull out the anchor element immediately and reinject mortar.

**11**

Wait for the specified curing time $t_{cure}$ see T**able B13.3**.

**12**




Mounting the fixture max $T_{inst}$ see **Table B12.1**.

**Table C1.1: Characteristic resistance to steel failure under tension / shear loading of metric Anchor rods / Threaded rods**

| Anchor rod / Threaded rod | | | | M8 | M10 | M12 | M14 | M16 | M20 | M22 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic resistance to steel failure under tension loading[3)]** | | | | | | | | | | | | | |
| Characteristic resistance $N_{Rk,s}$ | Steel zinc plated | Property class | 4.8 | 14,6(13,2) | 23,2(21,4) | 33,7 | 46,0 | 62,8 | 98,0 | 121,2 | 141,2 | 183,6 | 224,4 |
| | | | 5.8 | 18,3(16,6) | 29,0(26,8) | 42,1 | 57,5 | 78,5 | 122,5 | 151,5 | 176,5 | 229,5 | 280,5 |
| | | | 8.8 | 29,2(26,5) | 46,4(42,8) | 67,4 | 92,0 | 125,6 | 196,0 | 242,4 | 282,4 | 367,2 | 448,8 |
| | Stainless steel R and high corrosion resistant steel HCR | | 50 | 18,3 | 29,0 | 42,1 | 57,5 | 78,5 | 122,5 | 151,5 | 176,5 | 229,5 | 280,5 |
| | | | 70 | 25,6 | 40,6 | 59,0 | 80,5 | 109,9 | 171,5 | 212,1 | 247,1 | 321,3 | 392,7 |
| | | | 80 | 29,2 | 46,4 | 67,4 | 92,0 | 125,6 | 196,0 | 242,4 | 282,4 | 367,2 | 448,8 |
| | | [kN] | | | | | | | | | | | |
| **Partial factors [1)]** | | | | | | | | | | | | | |
| Partial factor $\gamma_{Ms,N}$ | Steel zinc plated | Property class | 4.8 | 1,50 | | | | | | | | | |
| | | | 5.8 | 1,50 | | | | | | | | | |
| | | | 8.8 | 1,50 | | | | | | | | | |
| | Stainless steel R and high corrosion resistant steel HCR | | 50 | 2,86 | | | | | | | | | |
| | | | 70 | 1,87 / fischer HCR: 1,50 | | | | | | | | | |
| | | | 80 | 1,60 | | | | | | | | | |
| | | [-] | | | | | | | | | | | |
| **Characteristic resistance to steel failure under shear loading[3)]** | | | | | | | | | | | | | |
| **without lever arm** | | | | | | | | | | | | | |
| Characteristic resistance $V^0_{Rk,s}$ | Steel zinc plated | Property class | 4.8 | 8,7(7,9) | 13,9(12,8) | 20,2 | 27,6 | 37,6 | 58,8 | 72,7 | 84,7 | 110,1 | 134,6 |
| | | | 5.8 | 10,9(9,9) | 17,4(16,0) | 25,2 | 34,5 | 47,1 | 73,5 | 90,9 | 105,9 | 137,7 | 168,3 |
| | | | 8.8 | 14,6(13,2) | 23,2(21,4) | 33,7 | 46,0 | 62,8 | 98,0 | 121,2 | 141,2 | 183,6 | 224,4 |
| | Stainless steel R and high corrosion resistant steel HCR | | 50 | 9,1 | 14,5 | 21,0 | 28,7 | 39,2 | 61,2 | 75,7 | 88,2 | 114,7 | 140,2 |
| | | | 70 | 12,8 | 20,3 | 29,5 | 40,2 | 54,9 | 85,7 | 106,0 | 123,5 | 160,6 | 196,3 |
| | | | 80 | 14,6 | 23,2 | 33,7 | 46,0 | 62,8 | 98,0 | 121,2 | 141,2 | 183,6 | 224,4 |
| | | [kN] | | | | | | | | | | | |
| Ductility factor | | $k_7$ | [-] | 1,0 | | | | | | | | | |
| **with lever arm** | | | | | | | | | | | | | |
| Charact. resistance $M^0_{Rk,s}$ | Steel zinc plated | Property class | 4.8 | 14,9(12,9) | 29,9(26,5) | 52,3 | 83,5 | 132,9 | 259,6 | 357,1 | 448,8 | 665,7 | 899,5 |
| | | | 5.8 | 18,7(16,1) | 37,3(33,2) | 65,4 | 104,4 | 166,2 | 324,6 | 446,4 | 561,0 | 832,2 | 1124,4 |
| | | | 8.8 | 29,9(25,9) | 59,8(53,1) | 104,6 | 167,0 | 265,9 | 519,3 | 714,2 | 897,6 | 1331,5 | 1799,0 |
| | Stainless steel R and high corrosion resistant steel HCR | | 50 | 18,7 | 37,3 | 65,4 | 104,4 | 166,2 | 324,6 | 446,4 | 561,0 | 832,2 | 1124,4 |
| | | | 70 | 26,2 | 52,3 | 91,5 | 146,1 | 232,6 | 454,4 | 624,9 | 785,4 | 1165,0 | 1574,1 |
| | | | 80 | 29,9 | 59,8 | 104,6 | 167,0 | 265,9 | 519,3 | 714,2 | 897,6 | 1331,5 | 1799,0 |
| | | [Nm] | | | | | | | | | | | |
| **Partial factors [1)]** | | | | | | | | | | | | | |
| Partial factor $\gamma_{Ms,V}$ | Steel zinc plated | Property class | 4.8 | 1,25 | | | | | | | | | |
| | | | 5.8 | 1,25 | | | | | | | | | |
| | | | 8.8 | 1,25 | | | | | | | | | |
| | Stainless steel R and high corrosion resistant steel HCR | | 50 | 2,38 | | | | | | | | | |
| | | | 70 | 1,56 / fischer HCR: 1,25[2)] | | | | | | | | | |
| | | | 80 | 1,33 | | | | | | | | | |
| | | [-] | | | | | | | | | | | |

[1)] In absence of other national regulations.
[2)] Only admissible for high corrosion resist. steel HCR, with $f_{yk}/f_{uk} \geq 0,8$ and $A_5 > 12$ % (e.g. Anchor rods).
[3)] Values in brackets are valid for undersized threaded rods with smaller stress area $A_s$ for hot dip galvanised Threaded rods according to EN ISO 10684:2004+AC:2009.

**Table C2.1: Characteristic resistance to steel failure under tension / shear loading of metric fischer RG M I**

| fischer RG M I | | | RG M I | Screw | | M8 | M10 | M12 | M16 | M20 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic resistance to steel failure under tension loading** | | | | | | | | | | |
| Characteristic resistance with screw | $N_{Rk,s}$ | Property class | 5.8 | 5.8 | [kN] | 18,3 | 29,0 | 42,1 | 78,3 | 122,4 |
| | | | | 8.8 | | 29,2 | 46,4 | 67,4 | 106,7 | 180,2 |
| | | Property class | R-70 / HCR-70 | R-70 / commercial standard | | 25,6 | 40,6 | 59,0 | 109,6 | 171,3 |
| | | | | HCR-70 | | 25,6 | 40,6 | 59,0 | 109,6 | 171,3 |
| **Partial factors**[1)] | | | | | | | | | | |
| Partial factors | $\gamma_{Ms,N}$ | Property class | 5.8 | 5.8 | [-] | 1,50 | | | | |
| | | | | 8.8 | | 1,50 | | | | |
| | | Property class | R-70 / HCR-70 | R-70/ commercial standard | | 1,87 | | | | |
| | | | | HCR-70 | | 1,50 | | | | |
| **Characteristic resistance to steel failure under shear loading** | | | | | | | | | | |
| **Without lever arm** | | | | | | | | | | |
| Characteristic resistance with screw | $V^0_{Rk,s}$ | Property class | 5.8 | 5.8 | [kN] | 10,9 | 17,4 | 25,2 | 47,1 | 73,5 |
| | | | | 8.8 | | 14,6 | 23,2 | 33,7 | 62,8 | 98,0 |
| | | Property class | R-70 / HCR-70 | R-70 / commercial standard | | 12,8 | 20,3 | 29,5 | 54,9 | 85,7 |
| | | | | HCR-70 | | 12,8 | 20,3 | 29,5 | 54,9 | 85,7 |
| Ductility factor | | | | $k_7$ | [-] | 1,0 | | | | |
| **With lever arm** | | | | | | | | | | |
| Characteristic resistance with screw | $M^0_{Rk,s}$ | Property class | 5.8 | 5.8 | [Nm] | 18,7 | 37,3 | 65,4 | 166,2 | 324,6 |
| | | | | 8.8 | | 29,9 | 59,8 | 104,6 | 265,9 | 519,3 |
| | | Property class | R-70/ HCR-70 | R-70 / commercial standard | | 26,2 | 52,3 | 91,5 | 232,6 | 454,4 |
| | | | | HCR-70 | | 26,2 | 52,3 | 91,5 | 232,6 | 454,4 |
| **Partial factors**[1)] | | | | | | | | | | |
| Partial factors | $\gamma_{Ms,V}$ | Property class | 5.8 | 5.8 | [-] | 1,25 | | | | |
| | | | | 8.8 | | 1,25 | | | | |
| | | Property class | R-70 / HCR-70 | R-70 / commercial standard | | 1,56 | | | | |
| | | | | HCR-70 | | 1,25 | | | | |

[1)] In absence of other national regulations.

**Table C3.1: Characteristic resistance to steel failure under tension / shear loading of metric reinforcing bars**

| Nominal diameter of the bar | | ϕ | 8 | 10 | 12 | 14 | 16 | 20 | 25 | 28 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic resistance to steel failure under tension loading** | | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | $A_s \cdot f_{uk}$ [1)] | | | | | | | |
| **Characteristic resistance to steel failure under shear loading** | | | | | | | | | | |
| **Without lever arm** | | | | | | | | | | |
| Characteristic resistance | $V^0_{Rk,s}$ | [kN] | $k_6$ [2)] $\cdot A_s \cdot f_{uk}$ [1)] | | | | | | | |
| Ductility factor | $k_7$ | [-] | 1,0 | | | | | | | |
| **With lever arm** | | | | | | | | | | |
| Characteristic resistance | $M^0_{Rk,s}$ | [Nm] | $1,2 \cdot W_{el} \cdot f_{uk}$ [1)] | | | | | | | |

1) $f_{uk}$ respectively shall be taken from the specifications of the reinforcing bar.
2) In accordance with EN 1992-4:2018 section 7.2.2.3.1:
$k_6$ = 0,6 for fasteners made of carbon steel with $f_{uk} \leq 500$ N/mm²,
= 0,5 for fasteners made of carbon steel with 500 N/mm² < $f_{uk} \leq 1000$ N/mm²,
= 0,5 for fasteners made of stainless steel.

**Table C3.2: Characteristic restistance to steel failure under tension / shear loading of metric fischer FRA**

| fischer FRA | | | M12 | M16 | M20 | M24 |
|---|---|---|---|---|---|---|
| **Characteristic resistance to steel failure under tension loading** | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | 62,1 | 110,5 | 172,7 | 263,0 |
| **Partial factor**[1)] | | | | | | |
| Partial factor | $\gamma_{Ms,N}$ | [-] | 1,40 | | | |
| **Characteristic resistance to steel failure under shear loading** | | | | | | |
| **Without lever arm** | | | | | | |
| Characteristic resistance | $V^0_{Rk,s}$ | [kN] | 33,7 | 62,8 | 98,0 | 141,2 |
| Ductility factor | $k_7$ | [-] | 1,0 | | | |
| **With lever arm** | | | | | | |
| Characteristic resistance | $M^0_{Rk,s}$ | [Nm] | 104,8 | 266,3 | 519,2 | 898,0 |
| **Partial factor**[1)] | | | | | | |
| Partial factor | $\gamma_{Ms,V}$ | [-] | 1,25 | | | |

1) In absence of other national regulations.

**Table C4.1: Characteristic resistance for concrete failure under tension / shear loading (metric size)**

| Size | | | All sizes |
|---|---|---|---|
| **Tension loading** | | | |
| Installation factor | $\gamma_{inst}$ | [-] | See annex C5 to C16, C40 and C41 |
| **Factors for the compressive strength of concrete > C20/25** | | | |
| Increasing factor $\psi_c$ for cracked or uncracked concrete $\tau_{Rk(X,Y)} = \psi_c \cdot \tau_{Rk(C20/25)}$ | C25/30 | $\Psi_c$ | 1,02 |
| | C30/37 | | 1,04 |
| | C35/45 | | 1,06 |
| | C40/50 | | 1,07 |
| | C45/55 | | 1,08 |
| | C50/60 | | 1,09 |
| **Splitting failure** | | | |
| Edge distance | $h / h_{ef} \geq 2,0$ | $c_{cr,sp}$ | $1,0\ h_{ef}$ |
| | $2,0 > h / h_{ef} > 1,3$ | | $4,6\ h_{ef} - 1,8\ h$ |
| | $h / h_{ef} \leq 1,3$ | | $2,26\ h_{ef}$ |
| Spacing | | $s_{cr,sp}$ | $2\ c_{cr,sp}$ |
| **Concrete cone failure** | | | |
| Uncracked concrete | $k_{ucr,N}$ | [-] | 11,0 |
| Cracked concrete | $k_{cr,N}$ | | 7,7 |
| Edge distance | $c_{cr,N}$ | [mm] | $1,5\ h_{ef}$ |
| Spacing | $s_{cr,N}$ | | $2\ c_{cr,N}$ |

| **Factors for sustained tension loading** | | | | | |
|---|---|---|---|---|---|
| Temperature range | | | 24 °C / 40 °C | 35 °C / 60 °C | 50 °C / 72 °C |
| Factor | $\psi^0_{sus}$ | | 0,77 | 0,60 | 0,48 |
| Factor | $\psi^0_{sus,100}$ | | 0,77 | 0,60 | 0,71 |

| **Shear loading** | | | |
|---|---|---|---|
| Installation factor | $\gamma_{inst}$ | [-] | 1,0 |
| **Concrete pry-out failure** | | | |
| Factor for pry-out failure | $k_8$ | [-] | 2,0 |
| **Concrete edge failure** | | | |
| Effective length of fastener for shear loading | $l_f$ | [mm] | for $d_{nom} \leq 24$ mm: min ($h_{ef}$; 12 $d_{nom}$)<br>for $d_{nom} > 24$ mm: min ($h_{ef}$; max (8 $d_{nom}$; 300 mm)) |

**Effective diameter of the fastener $d_{nom}$**

| Size | | | M8 | M10 | M12 | M14 | M16 | M20 | M22 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Anchor rods and Threaded rods | $d_{nom}$ | [mm] | 8 | 10 | 12 | 14 | 16 | 20 | 22 | 24 | 27 | 30 |
| fischer RG M I | $d_{nom}$ | | 12 | 15,7 | 18 | -[1)] | 22 | 28 | -[1)] | -[1)] | -[1)] | -[1)] |
| fischer FRA | $d_{nom}$ | | -[1)] | -[1)] | 12 | -[1)] | 16 | 20 | -[1)] | 25 | -[1)] | -[1)] |

| Size (nominal diameter of the bar) | | $\phi$ | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 25 | 26 | 28 | 30 | 32 | 34 | 36 | 40 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reinforcing bar | $d_{nom}$ | [mm] | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 25 | 26 | 28 | 30 | 32 | 34 | 36 | 40 |

[1)] Anchor type not part of the assessment.

**Table C5.1: Characteristic resistance to combined pull-out and concrete failure for metric Anchor rods and Threaded rods in hammer or diamond drilled holes; uncracked or cracked concrete; working life 50 years**

| Anchor rod / Threaded rod | | | | M8[1)] | M10 | M12 | M14 | M16 | M20 | M22 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | | | | | | | |
| Calculation diameter | | d | [mm] | 8 | 10 | 12 | 14 | 16 | 20 | 22 | 24 | 27 | 30 |
| **Uncracked concrete** | | | | | | | | | | | | | |
| **Characteristic bond resistance in uncracked concrete C20/25** | | | | | | | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 20,8 | 19,7 | 18,8 | 18,1 | 17,6 | 16,7 | 16,3 | 16,0 | 15,5 | 15,1 |
| | II: 35 °C / 60 °C | | | 18,0 | 18,0 | 18,0 | 17,0 | 17,0 | 16,0 | 15,0 | 15,0 | 15,0 | 14,0 |
| | III: 50 °C / 72 °C | | | 18,0 | 17,0 | 17,0 | 16,0 | 16,0 | 15,0 | 14,0 | 14,0 | 14,0 | 13,0 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 20,8 | 19,7 | 18,8 | 17,9 | 16,9 | 15,3 | 14,4 | 13,8 | 13,2 | 12,3 |
| | II: 35 °C / 60 °C | | | 16,0 | 16,0 | 15,0 | 13,0 | 13,0 | 11,0 | 11,0 | 10,0 | 10,0 | 9,0 |
| | III: 50 °C / 72 °C | | | 15,0 | 14,0 | 14,0 | 13,0 | 12,0 | 11,0 | 10,0 | 10,0 | 9,0 | 9,0 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | | |
| Water filled hole | | | | 1,4 | | | | | | | | | |
| Diamond-drilling (dry or wet concrete) | | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 16,0 | 15,0 | 13,5 | 12,8 | 12,4 | 11,6 | 11,3 | 10,9 | 10,5 | 10,3 |
| | II: 35 °C / 60 °C | | | 16,0 | 15,0 | 13,0 | 12,0 | 12,0 | 10,0 | 10,0 | 10,0 | 9,0 | 9,0 |
| | III: 50 °C / 72 °C | | | 15,0 | 14,0 | 12,0 | 11,0 | 11,0 | 10,0 | 9,0 | 9,0 | 8,0 | 8,0 |
| Diamond-drilling (water filled hole) | | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 16,0 | 16,8 | 15,5 | 14,3 | 13,6 | 12,0 | 11,5 | 10,9 | 10,3 | 9,9 |
| | II: 35 °C / 60 °C | | | 16,0 | 15,0 | 13,0 | 12,0 | 12,0 | 10,0 | 10,0 | 10,0 | 9,0 | 9,0 |
| | III: 50 °C / 72 °C | | | 15,0 | 14,0 | 12,0 | 11,0 | 11,0 | 10,0 | 9,0 | 9,0 | 8,0 | 8,0 |
| **Installation factors; Diamond-drilling** | | | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | | |
| Water filled hole | | | | 1,4 | | | | | | | | | |
| **Cracked concrete** | | | | | | | | | | | | | |
| **Characteristic bond resistance in cracked concrete C20/25** | | | | | | | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,7 | 9,0 | 10,1 | 8,5 | 9,5 | 8,5 | 8,5 | 8,5 | 8,5 | 8,5 |
| | II: 35 °C / 60 °C | | | 7,7 | 9,0 | 10,1 | 8,5 | 9,5 | 8,5 | 8,5 | 8,5 | 8,5 | 8,5 |
| | III: 50 °C / 72 °C | | | 7,2 | 8,5 | 9,5 | 8,5 | 8,9 | 8,5 | 8,5 | 8,5 | 8,5 | 8,5 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 6,6 | 7,7 | 8,7 | 7,0 | 7,7 | 6,0 | 6,0 | 6,0 | 6,0 | 6,0 |
| | II: 35 °C / 60 °C | | | 6,6 | 7,7 | 8,7 | 7,0 | 7,7 | 6,0 | 6,0 | 6,0 | 6,0 | 6,0 |
| | III: 50 °C / 72 °C | | | 6,2 | 7,3 | 8,1 | 7,0 | 7,3 | 6,0 | 6,0 | 6,0 | 6,0 | 6,0 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | | |
| Water filled hole | | | | 1,2 | | | | | 1,4 | | | | |
| Diamond-drilling (dry or wet concrete) | | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,0 | 7,0 | 7,0 | 7,0 | 6,0 | 6,0 | 7,0 | 7,0 | 7,0 | 7,0 |
| | II: 35 °C / 60 °C | | | 7,0 | 7,0 | 7,0 | 7,0 | 6,0 | 6,0 | 7,0 | 7,0 | 7,0 | 7,0 |
| | III: 50 °C / 72 °C | | | 7,0 | 7,0 | 7,0 | 7,0 | 6,0 | 6,0 | 7,0 | 7,0 | 7,0 | 7,0 |
| Diamond-drilling (water filled hole) | | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 6,0 | 7,5 | 7,5 | 7,0 | 6,0 | 6,0 | 6,0 | 6,0 | 6,0 | 6,0 |
| | II: 35 °C / 60 °C | | | 6,0 | 7,5 | 7,5 | 7,0 | 6,0 | 6,0 | 6,0 | 6,0 | 6,0 | 6,0 |
| | III: 50 °C / 72 °C | | | 6,0 | 7,0 | 7,0 | 7,0 | 6,0 | 6,0 | 6,0 | 6,0 | 6,0 | 6,0 |
| **Installation factors; Diamond-drilling** | | | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | | |
| Water filled hole | | | | 1,2 | | | | | 1,4 | | | | |

[1)] Not allowed for hollow drill bit.

fischer injection system FIS EM Plus

**Performance**
Characteristic resistance to combined pull-out and concrete failure for Anchor rods and Threaded rods; working life 50 years

**Annex C5**

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**Table C6.1: Characteristic resistance to combined pull-out and concrete failure for metric Anchor rods and Threaded rods in hammer or diamond drilled holes; uncracked or cracked concrete; working life 100 years**

| Anchor rod / Threaded rod | | | | M8[1)] | M10 | M12 | M14 | M16 | M20 | M22 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | | | | | | | |
| Calculation diameter | | d | [mm] | 8 | 10 | 12 | 14 | 16 | 20 | 22 | 24 | 27 | 30 |
| **Uncracked concrete** | | | | | | | | | | | | | |
| **Characteristic bond resistance in uncracked concrete C20/25** | | | | | | | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | | | | | | | |
| Tem- | I: | 24 °C / 40 °C | | 17,1 | 16,1 | 15,4 | 14,9 | 14,4 | 13,7 | 13,4 | 13,1 | 12,7 | 12,4 |
| perature | II: | 35 °C / 60 °C | $\tau_{Rk,100,ucr}$ [N/mm²] | 13,5 | 13,5 | 13,5 | 12,8 | 12,8 | 12,0 | 11,3 | 11,3 | 11,3 | 10,5 |
| range | III: | 50 °C / 72 °C | | 9,9 | 10,2 | 10,2 | 10,4 | 10,4 | 9,8 | 9,1 | 9,1 | 9,1 | 8,5 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | | | | | | | |
| Tem- | I: | 24 °C / 40 °C | | 17,1 | 16,2 | 15,4 | 14,7 | 13,9 | 12,5 | 11,8 | 11,3 | 10,8 | 10,1 |
| perature | II: | 35 °C / 60 °C | $\tau_{Rk,100,ucr}$ [N/mm²] | 12,0 | 12,0 | 11,3 | 9,8 | 9,8 | 8,3 | 8,3 | 7,5 | 7,5 | 6,8 |
| range | III: | 50 °C / 72 °C | | 8,3 | 8,4 | 8,4 | 8,5 | 7,8 | 7,2 | 6,5 | 6,5 | 5,9 | 5,9 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | | |
| Water filled hole | | | | 1,4 | | | | | | | | | |
| Diamond-drilling (dry or wet concrete) | | | | | | | | | | | | | |
| Tem- | I: | 24 °C / 40 °C | | 12,0 | 12,3 | 11,6 | 11,1 | 10,5 | 10,1 | 9,5 | 9,3 | 8,9 | 8,8 |
| perature | II: | 35 °C / 60 °C | $\tau_{Rk,100,ucr}$ [N/mm²] | 12,0 | 11,3 | 9,8 | 9,0 | 9,0 | 7,5 | 7,5 | 7,5 | 6,8 | 6,8 |
| range | III: | 50 °C / 72 °C | | 8,3 | 8,4 | 7,2 | 7,2 | 7,2 | 6,5 | 5,9 | 5,9 | 5,2 | 5,2 |
| Diamond-drilling (water filled hole) | | | | | | | | | | | | | |
| Tem- | I: | 24 °C / 40 °C | | 12,0 | 13,8 | 12,7 | 11,7 | 11,2 | 10,0 | 9,4 | 8,9 | 8,4 | 8,1 |
| perature | II: | 35 °C / 60 °C | $\tau_{Rk,100,ucr}$ [N/mm²] | 12,0 | 11,3 | 9,8 | 9,0 | 9,0 | 7,5 | 7,5 | 7,5 | 6,8 | 6,8 |
| range | III: | 50 °C / 72 °C | | 8,3 | 8,4 | 7,2 | 7,2 | 7,2 | 6,5 | 5,9 | 5,9 | 5,2 | 5,2 |
| **Installation factors** | | | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | | |
| Water filled hole | | | | 1,4 | | | | | | | | | |
| **Cracked concrete** | | | | | | | | | | | | | |
| **Characteristic bond resistance in cracked concrete C20/25** | | | | | | | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | | | | | | | |
| Tem- | I: | 24 °C / 40 °C | | 5,7 | 7,0 | 7,6 | 7,4 | 7,2 | 6,9 | 6,8 | 6,7 | 6,5 | 6,3 |
| perature | II: | 35 °C / 60 °C | $\tau_{Rk,100,cr}$ [N/mm²] | 5,7 | 7,0 | 7,6 | 7,4 | 7,2 | 6,9 | 6,8 | 6,7 | 6,5 | 6,3 |
| range | III: | 50 °C / 72 °C | | 5,4 | 6,6 | 7,2 | 7,0 | 6,8 | 6,4 | 6,4 | 6,3 | 6,1 | 6,0 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | | | | | | | |
| Tem- | I: | 24 °C / 40 °C | | 4,9 | 6,0 | 6,5 | 6,1 | 5,9 | 4,9 | 4,8 | 4,7 | 4,6 | 4,4 |
| perature | II: | 35 °C / 60 °C | $\tau_{Rk,100,cr}$ [N/mm²] | 4,9 | 6,0 | 6,5 | 6,1 | 5,9 | 4,9 | 4,8 | 4,7 | 4,6 | 4,4 |
| range | III: | 50 °C / 72 °C | | 4,6 | 5,7 | 6,1 | 5,7 | 5,5 | 4,5 | 4,5 | 4,4 | 4,3 | 4,3 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | | |
| Water filled hole | | | | 1,2 | | | | | 1,4 | | | | |
| Diamond-drilling (dry or wet concrete) | | | | | | | | | | | | | |
| Tem- | I: | 24 °C / 40 °C | | 4,2 | 6,0 | 5,6 | 4,6 | 3,9 | 3,9 | 4,6 | 4,6 | 4,6 | 4,6 |
| perature | II: | 35 °C / 60 °C | $\tau_{Rk,100,cr}$ [N/mm²] | 4,2 | 6,0 | 5,6 | 4,6 | 3,9 | 3,9 | 4,6 | 4,6 | 4,6 | 4,6 |
| range | III: | 50 °C / 72 °C | | 4,2 | 6,0 | 5,6 | 4,6 | 3,9 | 3,9 | 4,6 | 4,6 | 4,6 | 4,6 |
| **Installation factors** | | | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | | |

[1)] Not allowed for hollow drill bit.

**Table C7.1: Characteristic resistance to combined pull-out and concrete failure for metric fischer RG M I in hammer or diamond drilled holes; uncracked or cracked concrete; working life 50 years**

| fischer RG M I | | | | M8 | M10 | M12 | M16 | M20 |
|---|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | | |
| Calculation diameter | | d | [mm] | 12 | 15,7 | 18 | 22 | 28 |
| **Uncracked concrete** | | | | | | | | |
| **Characteristic bond resistance in uncracked concrete C20/25** | | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 18,8 | 17,6 | 17,0 | 16,2 | 15,3 |
| | II: 35 °C / 60 °C | | | 15,0 | 14,0 | 14,0 | 13,0 | 12,0 |
| | III: 50 °C / 72 °C | | | 14,0 | 13,0 | 13,0 | 12,0 | 11,0 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 18,8 | 16,9 | 15,8 | 14,3 | 12,8 |
| | II: 35 °C / 60 °C | | | 14,0 | 12,0 | 12,0 | 11,0 | 10,0 |
| | III: 50 °C / 72 °C | | | 13,0 | 12,0 | 11,0 | 10,0 | 9,0 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | |
| Water filled hole | | | | 1,4 | | | | |
| Diamond-drilling (dry or wet concrete) | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 13,3 | 12,3 | 11,9 | 11,2 | 10,4 |
| | II: 35 °C / 60 °C | | | 13,0 | 12,0 | 11,0 | 10,0 | 9,0 |
| | III: 50 °C / 72 °C | | | 12,0 | 11,0 | 10,0 | 9,0 | 8,0 |
| Diamond-drilling (water filled hole) | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 15,1 | 13,6 | 12,6 | 11,4 | 10,2 |
| | II: 35 °C / 60 °C | | | 13,0 | 12,0 | 11,0 | 10,0 | 9,0 |
| | III: 50 °C / 72 °C | | | 12,0 | 11,0 | 10,0 | 9,0 | 8,0 |
| **Installation factors; Diamond-drilling** | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | |
| Water filled hole | | | | 1,4 | | | | |
| **Cracked concrete** | | | | | | | | |
| **Characteristic bond resistance in cracked concrete C20/25** | | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,0 | 6,0 | 6,0 | 7,0 | 7,0 |
| | II: 35 °C / 60 °C | | | 7,0 | 6,0 | 6,0 | 7,0 | 7,0 |
| | III: 50 °C / 72 °C | | | 7,0 | 6,0 | 6,0 | 7,0 | 7,0 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,0 | 6,5 | 6,0 | 6,0 | 6,0 |
| | II: 35 °C / 60 °C | | | 7,0 | 6,5 | 6,0 | 6,0 | 6,0 |
| | III: 50 °C / 72 °C | | | 7,0 | 6,0 | 6,0 | 6,0 | 6,0 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | |
| Water filled hole | | | | 1,2 | | | 1,4 | |
| Diamond-drilling (dry or wet concrete) | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,0 | 6,0 | 6,0 | 7,0 | 7,0 |
| | II: 35 °C / 60 °C | | | 7,0 | 6,0 | 6,0 | 7,0 | 7,0 |
| | III: 50 °C / 72 °C | | | 7,0 | 6,0 | 6,0 | 7,0 | 7,0 |
| Diamond-drilling (water filled hole) | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,0 | 6,5 | 6,0 | 6,0 | 6,0 |
| | II: 35 °C / 60 °C | | | 7,0 | 6,5 | 6,0 | 6,0 | 6,0 |
| | III: 50 °C / 72 °C | | | 7,0 | 6,0 | 6,0 | 6,0 | 6,0 |
| **Installation factors; Diamond-drilling** | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | |
| Water filled hole | | | | 1,2 | | | 1,4 | |

**Table C8.1: Characteristic resistance to combined pull-out and concrete failure for metric fischer RG M I in hammer or diamond drilled holes; uncracked or cracked concrete; working life 100 years**

| fischer RG M I | | | M8 | M10 | M12 | M16 | M20 |
|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | |
| Calculation diameter | d | [mm] | 12 | 15,7 | 18 | 22 | 28 |
| **Uncracked concrete** | | | | | | | |
| **Characteristic bond resistance in uncracked concrete C20/25** | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | |
| Temperature range I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 15,4 | 14,4 | 14,0 | 13,3 | 12,6 |
| Temperature range II: 35 °C / 60 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 11,3 | 10,5 | 10,5 | 9,8 | 9,0 |
| Temperature range III: 50 °C / 72 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 7,7 | 7,8 | 7,8 | 7,8 | 7,2 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | |
| Temperature range I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 15,4 | 13,9 | 13,0 | 11,7 | 10,5 |
| Temperature range II: 35 °C / 60 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 10,5 | 9,0 | 9,0 | 8,3 | 7,5 |
| Temperature range III: 50 °C / 72 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 7,2 | 7,2 | 6,6 | 6,5 | 5,9 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | |
| Dry or wet concrete | $\gamma_{inst}$ | [-] | 1,0 | | | | |
| Water filled hole | $\gamma_{inst}$ | [-] | 1,4 | | | | |
| Diamond-drilling (dry or wet concrete) | | | | | | | |
| Temperature range I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 10,9 | 10,1 | 9,8 | 9,2 | 8,6 |
| Temperature range II: 35 °C / 60 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 9,8 | 9,0 | 8,3 | 7,5 | 6,8 |
| Temperature range III: 50 °C / 72 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 6,6 | 6,6 | 6,0 | 5,9 | 5,2 |
| Diamond-drilling (water filled hole) | | | | | | | |
| Temperature range I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 12,5 | 11,2 | 10,3 | 9,3 | 8,4 |
| Temperature range II: 35 °C / 60 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 9,8 | 9,0 | 8,3 | 7,5 | 6,8 |
| Temperature range III: 50 °C / 72 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 6,6 | 6,6 | 6,0 | 5,9 | 5,2 |
| **Installation factors; Diamond-drilling** | | | | | | | |
| Dry or wet concrete | $\gamma_{inst}$ | [-] | 1,0 | | | | |
| Water filled hole | $\gamma_{inst}$ | [-] | 1,4 | | | | |
| **Cracked concrete** | | | | | | | |
| **Characteristic bond resistance in cracked concrete C20/25** | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | |
| Temperature range I: 24 °C / 40 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 4,2 | 5,1 | 4,8 | 4,6 | 4,6 |
| Temperature range II: 35 °C / 60 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 4,2 | 5,1 | 4,8 | 4,6 | 4,6 |
| Temperature range III: 50 °C / 72 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 4,2 | 5,1 | 4,8 | 4,6 | 4,6 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | |
| Temperature range I: 24 °C / 40 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 4,2 | 5,5 | 4,8 | 3,9 | 3,9 |
| Temperature range II: 35 °C / 60 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 4,2 | 5,5 | 4,8 | 3,9 | 3,9 |
| Temperature range III: 50 °C / 72 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 4,2 | 5,1 | 4,8 | 3,9 | 3,9 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | |
| Dry or wet concrete | $\gamma_{inst}$ | [-] | 1,0 | | | | |
| Water filled hole | $\gamma_{inst}$ | [-] | 1,2 | | | 1,4 | |
| Diamond-drilling (dry or wet concrete) | | | | | | | |
| Temperature range I: 24 °C / 40 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 4,2 | 5,1 | 4,8 | 4,6 | 4,6 |
| Temperature range II: 35 °C / 60 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 4,2 | 5,1 | 4,8 | 4,6 | 4,6 |
| Temperature range III: 50 °C / 72 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 4,2 | 5,1 | 4,8 | 4,6 | 4,6 |
| **Installation factors; Diamond-drilling** | | | | | | | |
| Dry or wet concrete | $\gamma_{inst}$ | [-] | 1,0 | | | | |

**Table C9.1: Characteristic resistance to combined pull-out and concrete failure for metric reinforcing bars in hammer or diamond drilled holes; uncracked concrete; working life 50 years**

| Nominal diameter of the bar | | | ϕ | 8[1] | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | | | | | | |
| Calculation diameter | | d | [mm] | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
| **Uncracked concrete** | | | | | | | | | | | | |
| **Characteristic bond resistance in uncracked concrete C20/25** | | | | | | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 16,0 | 16,8 | 16,1 | 15,5 | 15,0 | 14,6 | 14,2 | 14,0 | 13,6 |
| | II: 35 °C / 60 °C | | | 16,0 | 15,0 | 15,0 | 14,0 | 14,0 | 13,0 | 13,0 | 13,0 | 12,0 |
| | III: 50 °C / 72 °C | | | 15,0 | 14,0 | 14,0 | 13,0 | 13,0 | 12,0 | 12,0 | 12,0 | 12,0 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 16,0 | 16,8 | 16,1 | 14,9 | 14,4 | 13,4 | 13,0 | 12,1 | 11,8 |
| | II: 35 °C / 60 °C | | | 16,0 | 16,0 | 14,0 | 13,0 | 12,0 | 12,0 | 11,0 | 11,0 | 10,0 |
| | III: 50 °C / 72 °C | | | 15,0 | 14,0 | 13,0 | 12,0 | 12,0 | 11,0 | 11,0 | 10,0 | 10,0 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | |
| Water filled hole | | | | 1,4 | | | | | | | | |
| Diamond-drilling (dry or wet concrete as well as water filled hole) | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 16,0 | 15,0 | 13,0 | 12,0 | 12,0 | 11,0 | 10,0 | 10,0 | 10,0 |
| | II: 35 °C / 60 °C | | | 16,0 | 15,0 | 13,0 | 12,0 | 12,0 | 11,0 | 10,0 | 10,0 | 10,0 |
| | III: 50 °C / 72 °C | | | 15,0 | 14,0 | 12,0 | 11,0 | 11,0 | 10,0 | 10,0 | 9,0 | 9,0 |
| **Installation factors; Diamond-drilling** | | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | |
| Water filled hole | | | | 1,4 | | | | | | | | |

| Nominal diameter of the bar | | | ϕ | 25 | 26 | 28 | 30[1] | 32[1] | 34[1] | 36[1] | 40[1] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | | | | | |
| Calculation diameter | | d | [mm] | 25 | 26 | 28 | 30 | 32 | 34 | 36 | 40 |
| **Uncracked concrete** | | | | | | | | | | | |
| **Characteristic bond resistance in uncracked concrete C20/25** | | | | | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 13,5 | 13,3 | 13,1 | 12,9 | 12,7 | 12,5 | 12,4 | 12,1 |
| | II: 35 °C / 60 °C | | | 12,0 | 12,0 | 12,0 | 12,0 | 12,0 | 11,0 | 11,0 | 11,0 |
| | III: 50 °C / 72 °C | | | 11,0 | 11,0 | 11,0 | 11,0 | 11,0 | 11,0 | 10,0 | 10,0 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 11,5 | 11,4 | 10,6 | 10,5 | 10,3 | 9,0 | 8,0 | 8,0 |
| | II: 35 °C / 60 °C | | | 10,0 | 10,0 | 10,0 | 9,0 | 9,0 | 9,0 | 8,0 | 8,0 |
| | III: 50 °C / 72 °C | | | 9,0 | 9,0 | 9,0 | 9,0 | 8,0 | 8,0 | 8,0 | 8,0 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |
| Water filled hole | | | | 1,4 | | | | | | | |
| Diamond-drilling (dry or wet concrete as well as water filled hole) | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 9,0 | 9,0 | 9,0 | 9,0 | 8,0 | 8,0 | 8,0 | 7,0 |
| | II: 35 °C / 60 °C | | | 9,0 | 9,0 | 9,0 | 9,0 | 8,0 | 8,0 | 8,0 | 7,0 |
| | III: 50 °C / 72 °C | | | 9,0 | 8,0 | 8,0 | 8,0 | 8,0 | 7,0 | 7,0 | 7,0 |
| **Installation factors; Diamond-drilling** | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |
| Water filled hole | | | | 1,4 | | | | | | | |

[1] Not allowed for hollow drill bit.

fischer injection system FIS EM Plus

**Performance**
Characteristic resistance to combined pull-out and concrete failure for reinforcing bars; working life 50 years

**Annex C9**

**Table C10.1: Characteristic resistance to combined pull-out and concrete failure for metric reinforcing bars in hammer or diamond drilled holes; cracked concrete; working life 50 years part 1**

| Nominal diameter of the bar | | | ϕ | 8[1)] | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | | | | | | |
| Calculation diameter | | d | [mm] | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
| **Cracked concrete** | | | | | | | | | | | | |
| **Characteristic bond resistance in cracked concrete C20/25** | | | | | | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,0 | 7,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 |
| | II: 35 °C / 60 °C | | | 7,0 | 7,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 |
| | III: 50 °C / 72 °C | | | 7,0 | 7,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 6,0 | 7,5 | 6,5 | 6,5 | 6,5 | 6,0 | 6,0 | 6,0 | 6,0 |
| | II: 35 °C / 60 °C | | | 6,0 | 7,5 | 6,5 | 6,5 | 6,5 | 6,0 | 6,0 | 6,0 | 6,0 |
| | III: 50 °C / 72 °C | | | 6,0 | 6,5 | 6,5 | 6,0 | 6,0 | 6,0 | 6,0 | 6,0 | 6,0 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | |
| Water filled hole | | | | 1,2 | | | | | | 1,4 | | |
| Diamond-drilling (dry or wet concrete) | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,0 | 7,0 | 7,0 | 7,0 | 6,0 | 6,0 | 6,0 | 7,0 | 7,0 |
| | II: 35 °C / 60 °C | | | 7,0 | 7,0 | 7,0 | 7,0 | 6,0 | 6,0 | 6,0 | 7,0 | 7,0 |
| | III: 50 °C / 72 °C | | | 7,0 | 7,0 | 7,0 | 7,0 | 6,0 | 6,0 | 6,0 | 7,0 | 7,0 |
| Diamond-drilling (water filled hole) | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 6,0 | 7,5 | 6,5 | 6,5 | 6,5 | 6,0 | 6,0 | 6,0 | 6,0 |
| | II: 35 °C / 60 °C | | | 6,0 | 7,5 | 6,5 | 6,5 | 6,5 | 6,0 | 6,0 | 6,0 | 6,0 |
| | III: 50 °C / 72 °C | | | 6,0 | 6,5 | 6,5 | 6,0 | 6,0 | 6,0 | 6,0 | 6,0 | 6,0 |
| **Installation factors; Diamond-drilling** | | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | |
| Water filled hole | | | | 1,2 | | | | | | 1,4 | | |

[1)] Not allowed for hollow drill bit.

**Table C11.1: Characteristic resistance to combined pull-out and concrete failure for metric reinforcing bars in hammer or diamond drilled holes; cracked concrete; working life 50 years part 2**

| Nominal diameter of the bar | | $\phi$ | | 25 | 26 | 28 | 30[1)] | 32[1)] | 34[1)] | 36[1)] | 40[1)] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | | | | | |
| Calculation diameter | | d | [mm] | 25 | 26 | 28 | 30 | 32 | 34 | 36 | 40 |
| **Cracked concrete** | | | | | | | | | | | |
| **Characteristic bond resistance in cracked concrete C20/25** | | | | | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 |
| | II: 35 °C / 60 °C | | | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 |
| | III: 50 °C / 72 °C | | | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 6,0 | 6,0 | 6,0 | 6,0 | 5,0 | 5,0 | 5,0 | 5,0 |
| | II: 35 °C / 60 °C | | | 6,0 | 6,0 | 6,0 | 6,0 | 5,0 | 5,0 | 5,0 | 5,0 |
| | III: 50 °C / 72 °C | | | 6,0 | 6,0 | 6,0 | 6,0 | 5,0 | 5,0 | 5,0 | 5,0 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |
| Water filled hole | | | | 1,4 | | | | | | | |
| Diamond-drilling (dry or wet concrete) | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,0 | 7,0 | 7,0 | 7,0 | 5,0 | 5,0 | 5,0 | 5,0 |
| | II: 35 °C / 60 °C | | | 7,0 | 7,0 | 7,0 | 7,0 | 5,0 | 5,0 | 5,0 | 5,0 |
| | III: 50 °C / 72 °C | | | 7,0 | 7,0 | 7,0 | 7,0 | 5,0 | 5,0 | 5,0 | 5,0 |
| Diamond-drilling (water filled hole) | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 6,0 | 6,0 | 6,0 | 6,0 | 5,0 | 5,0 | 5,0 | 5,0 |
| | II: 35 °C / 60 °C | | | 6,0 | 6,0 | 6,0 | 6,0 | 5,0 | 5,0 | 5,0 | 5,0 |
| | III: 50 °C / 72 °C | | | 6,0 | 6,0 | 6,0 | 6,0 | 5,0 | 5,0 | 5,0 | 5,0 |
| **Installation factors; Diamond-drilling** | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |
| Water filled hole | | | | 1,4 | | | | | | | |

[1)] Not allowed for hollow drill bit.

**Table C12.1: Characteristic resistance to combined pull-out and concrete failure for metric reinforcing bars in hammer or diamond drilled holes; uncracked concrete; working life 100 years**

| Nominal diameter of the bar | | | ϕ | 8[1] | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | | | | | | |
| Calculation diameter | | d | [mm] | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
| **Uncracked concrete** | | | | | | | | | | | | |
| **Characteristic bond resistance in uncracked concrete C20/25** | | | | | | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 12,0 | 13,8 | 13,2 | 12,7 | 12,3 | 12,0 | 11,6 | 11,5 | 11,2 |
| | II: 35 °C / 60 °C | | | 12,0 | 11,3 | 11,3 | 10,5 | 10,5 | 9,8 | 9,8 | 9,8 | 9,0 |
| | III: 50 °C / 72 °C | | | 8,3 | 8,4 | 8,4 | 8,5 | 8,5 | 7,8 | 7,8 | 7,8 | 7,8 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 12,0 | 13,8 | 13,2 | 12,2 | 11,8 | 11,0 | 10,7 | 9,9 | 9,7 |
| | II: 35 °C / 60 °C | | | 12,0 | 12,0 | 10,5 | 9,8 | 9,0 | 9,0 | 8,3 | 8,3 | 7,5 |
| | III: 50 °C / 72 °C | | | 8,3 | 8,4 | 7,8 | 7,8 | 7,8 | 7,2 | 7,2 | 6,5 | 6,5 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | |
| Water filled hole | | | | 1,4 | | | | | | | | |
| Diamond-drilling (dry or wet concrete as well as water filled hole) | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 12,0 | 11,3 | 9,8 | 9,0 | 9,0 | 8,3 | 7,5 | 7,5 | 7,5 |
| | II: 35 °C / 60 °C | | | 12,0 | 11,3 | 9,8 | 9,0 | 9,0 | 8,3 | 7,5 | 7,5 | 7,5 |
| | III: 50 °C / 72 °C | | | 8,3 | 8,4 | 7,2 | 7,2 | 7,2 | 6,5 | 6,5 | 5,9 | 5,9 |
| **Installation factors; Diamond-drilling** | | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | |
| Water filled hole | | | | 1,4 | | | | | | | | |

| Nominal diameter of the bar | | | ϕ | 25 | 26 | 28 | 30[1] | 32[1] | 34[1] | 36[1] | 40[1] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | | | | | |
| Calculation diameter | | d | [mm] | 25 | 26 | 28 | 30 | 32 | 34 | 36 | 40 |
| **Uncracked concrete** | | | | | | | | | | | |
| **Characteristic bond resistance in uncracked concrete C20/25** | | | | | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 11,1 | 10,9 | 10,8 | 10,6 | 10,5 | 10,3 | 10,1 | 9,9 |
| | II: 35 °C / 60 °C | | | 9,0 | 9,0 | 9,0 | 9,0 | 9,0 | 8,3 | 8,3 | 8,3 |
| | III: 50 °C / 72 °C | | | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 7,2 | 6,5 | 6,5 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 9,4 | 9,3 | 8,7 | 8,6 | 8,5 | 6,8 | 6,0 | 6,0 |
| | II: 35 °C / 60 °C | | | 7,5 | 7,5 | 7,5 | 6,8 | 6,8 | 6,8 | 6,0 | 6,0 |
| | III: 50 °C / 72 °C | | | 5,9 | 5,9 | 5,9 | 5,9 | 5,2 | 5,2 | 5,2 | 5,2 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |
| Water filled hole | | | | 1,4 | | | | | | | |
| Diamond-drilling (dry or wet concrete as well as water filled hole) | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 6,8 | 6,8 | 6,8 | 6,8 | 6,0 | 6,0 | 6,0 | 5,3 |
| | II: 35 °C / 60 °C | | | 6,8 | 6,8 | 6,8 | 6,8 | 6,0 | 6,0 | 6,0 | 5,3 |
| | III: 50 °C / 72 °C | | | 5,9 | 5,2 | 5,2 | 5,2 | 5,2 | 4,6 | 4,6 | 4,6 |
| **Installation factors; Diamond-drilling** | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |
| Water filled hole | | | | 1,4 | | | | | | | |

[1] Not allowed for hollow drill bit.

**Table C13.1: Characteristic resistance to combined pull-out and concrete failure for metric reinforcing bars in hammer or diamond drilled holes; cracked concrete; working life 100 years**

| Nominal diameter of the bar | | | ϕ | 8[1] | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | | | | | | |
| Calculation diameter | | d | [mm] | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
| **Cracked concrete** | | | | | | | | | | | | |
| **Characteristic bond resistance in cracked concrete C20/25** | | | | | | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 4,2 | 6,0 | 6,4 | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 |
| | II: 35 °C / 60 °C | | | 4,2 | 6,0 | 6,4 | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 |
| | III: 50 °C / 72 °C | | | 4,2 | 6,0 | 6,4 | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 3,6 | 6,4 | 5,2 | 4,2 | 4,2 | 3,9 | 3,9 | 3,9 | 3,9 |
| | II: 35 °C / 60 °C | | | 3,6 | 6,4 | 5,2 | 4,2 | 4,2 | 3,9 | 3,9 | 3,9 | 3,9 |
| | III: 50 °C / 72 °C | | | 3,6 | 5,5 | 5,2 | 3,9 | 3,9 | 3,9 | 3,9 | 3,9 | 3,9 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | |
| Water filled hole | | | | 1,2 | | | | | | 1,4 | | |
| Diamond-drilling (dry or wet concrete) | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 4,2 | 6,0 | 5,6 | 4,6 | 3,9 | 3,9 | 3,9 | 4,6 | 4,6 |
| | II: 35 °C / 60 °C | | | 4,2 | 6,0 | 5,6 | 4,6 | 3,9 | 3,9 | 3,9 | 4,6 | 4,6 |
| | III: 50 °C / 72 °C | | | 4,2 | 6,0 | 5,6 | 4,6 | 3,9 | 3,9 | 3,9 | 4,6 | 4,6 |
| **Installation factor; Diamond-drilling** | | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | |

| Nominal diameter of the bar | | | ϕ | 25 | 26 | 28 | 30[1] | 32[1] | 34[1] | 36[1] | 40[1] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | | | | | |
| Calculation diameter | | d | [mm] | 25 | 26 | 28 | 30 | 32 | 34 | 36 | 40 |
| **Cracked concrete** | | | | | | | | | | | |
| **Characteristic bond resistance in cracked concrete C20/25** | | | | | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 |
| | II: 35 °C / 60 °C | | | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 |
| | III: 50 °C / 72 °C | | | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 3,9 | 3,9 | 3,9 | 3,9 | 3,3 | 3,8 | 3,8 | 3,8 |
| | II: 35 °C / 60 °C | | | 3,9 | 3,9 | 3,9 | 3,9 | 3,3 | 3,8 | 3,8 | 3,8 |
| | III: 50 °C / 72 °C | | | 3,9 | 3,9 | 3,9 | 3,9 | 3,3 | 3,3 | 3,3 | 3,3 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |
| Water filled hole | | | | 1,4 | | | | | | | |
| Diamond-drilling (dry or wet concrete) | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 4,6 | 4,6 | 4,6 | 4,6 | 3,3 | 3,3 | 3,3 | 3,3 |
| | II: 35 °C / 60 °C | | | 4,6 | 4,6 | 4,6 | 4,6 | 3,3 | 3,3 | 3,3 | 3,3 |
| | III: 50 °C / 72 °C | | | 4,6 | 4,6 | 4,6 | 4,6 | 3,3 | 3,3 | 3,3 | 3,3 |
| **Installation factor; Diamond-drilling** | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |

[1] Not allowed for hollow drill bit.

**Table C14.1: Characteristic resistance to combined pull-out and concrete failure for metric fischer FRA in hammer or diamond drilled holes; uncracked concrete; working life 50 years**

| fischer FRA | | | | M12 | M16 | M20 | M24 |
|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | |
| Calculation diameter | | d | [mm] | 12 | 16 | 20 | 25 |
| **Uncracked concrete** | | | | | | | |
| **Characteristic bond resistance in uncracked concrete C20/25** | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 16,1 | 15,0 | 14,2 | 13,5 |
| | II: 35 °C / 60 °C | | | 15,0 | 14,0 | 13,0 | 12,0 |
| | III: 50 °C / 72 °C | | | 14,0 | 13,0 | 12,0 | 11,0 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 16,1 | 14,4 | 13,0 | 11,5 |
| | II: 35 °C / 60 °C | | | 14,0 | 12,0 | 11,0 | 10,0 |
| | III: 50 °C / 72 °C | | | 13,0 | 12,0 | 11,0 | 9,0 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | |
| Water filled hole | | | | 1,4 | | | |
| Diamond-drilling (dry or wet concrete as well as water filled hole) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 13,0 | 12,0 | 10,0 | 9,0 |
| | II: 35 °C / 60 °C | | | 13,0 | 12,0 | 10,0 | 9,0 |
| | III: 50 °C / 72 °C | | | 12,0 | 11,0 | 10,0 | 9,0 |
| **Installation factors; Diamond-drilling** | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | |
| Water filled hole | | | | 1,4 | | | |

**Table C15.1: Characteristic resistance to combined pull-out and concrete failure for metric fischer FRA in hammer or diamond drilled holes; cracked concrete; working life 50 years**

| fischer FRA | | | | M12 | M16 | M20 | M24 |
|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | |
| Calculation diameter | | d | [mm] | 12 | 16 | 20 | 25 |
| **Cracked concrete** | | | | | | | |
| **Characteristic bond resistance in cracked concrete C20/25** | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 8,0 | 8,0 | 8,0 | 8,0 |
| | II: 35 °C / 60 °C | | | 8,0 | 8,0 | 8,0 | 8,0 |
| | III: 50 °C / 72 °C | | | 8,0 | 8,0 | 8,0 | 8,0 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 6,5 | 6,5 | 6,0 | 6,0 |
| | II: 35 °C / 60 °C | | | 6,5 | 6,5 | 6,0 | 6,0 |
| | III: 50 °C / 72 °C | | | 6,5 | 6,0 | 6,0 | 6,0 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | |
| Water filled hole | | | | 1,2 | | 1,4 | |
| Diamond-drilling (dry or wet concrete) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,0 | 6,0 | 6,0 | 7,0 |
| | II: 35 °C / 60 °C | | | 7,0 | 6,0 | 6,0 | 7,0 |
| | III: 50 °C / 72 °C | | | 7,0 | 6,0 | 6,0 | 7,0 |
| Diamond-drilling (water filled hole) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 6,5 | 6,5 | 6,0 | 6,0 |
| | II: 35 °C / 60 °C | | | 6,5 | 6,5 | 6,0 | 6,0 |
| | III: 50 °C / 72 °C | | | 6,5 | 6,0 | 6,0 | 6,0 |
| **Installation factors; Diamond-drilling** | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | |
| Water filled hole | | | | 1,2 | | 1,4 | |

**Table C16.1: Characteristic resistance to combined pull-out and concrete failure for metric fischer FRA in hammer or diamond drilled holes; uncracked or cracked concrete; working life 100 years**

| fischer FRA | | | | M12 | M16 | M20 | M24 |
|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | |
| Calculation diameter | | d | [mm] | 12 | 16 | 20 | 25 |
| **Uncracked concrete** | | | | | | | |
| **Characteristic bond resistance in uncracked concrete C20/25** | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 13,2 | 12,3 | 11,6 | 11,1 |
| | II: 35 °C / 60 °C | | | 11,3 | 10,5 | 9,8 | 9,0 |
| | III: 50 °C / 72 °C | | | 8,4 | 8,5 | 7,8 | 7,2 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 13,2 | 11,8 | 10,7 | 9,4 |
| | II: 35 °C / 60 °C | | | 10,5 | 9,0 | 8,3 | 7,5 |
| | III: 50 °C / 72 °C | | | 7,8 | 7,8 | 7,2 | 5,9 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | |
| Water filled hole | | | | 1,4 | | | |
| Diamond-drilling (dry or wet concrete as well as water filled hole) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 9,8 | 9,0 | 7,5 | 6,8 |
| | II: 35 °C / 60 °C | | | 9,8 | 9,0 | 7,5 | 6,8 |
| | III: 50 °C / 72 °C | | | 7,2 | 7,2 | 6,5 | 5,9 |
| **Installation factors; Diamond-drilling** | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | |
| Water filled hole | | | | 1,4 | | | |

| fischer FRA | | | | M12 | M16 | M20 | M24 |
|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | |
| Calculation diameter | | d | [mm] | 12 | 16 | 20 | 25 |
| **Cracked concrete** | | | | | | | |
| **Characteristic bond resistance in cracked concrete C20/25** | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 6,4 | 5,2 | 5,2 | 5,2 |
| | II: 35 °C / 60 °C | | | 6,4 | 5,2 | 5,2 | 5,2 |
| | III: 50 °C / 72 °C | | | 6,4 | 5,2 | 5,2 | 5,2 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 5,2 | 4,2 | 3,9 | 3,9 |
| | II: 35 °C / 60 °C | | | 5,2 | 4,2 | 3,9 | 3,9 |
| | III: 50 °C / 72 °C | | | 5,2 | 3,9 | 3,9 | 3,9 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | |
| Water filled hole | | | | 1,2 | | 1,4 | |
| Diamond-drilling (dry or wet concrete) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 5,6 | 3,9 | 3,9 | 4,6 |
| | II: 35 °C / 60 °C | | | 5,6 | 3,9 | 3,9 | 4,6 |
| | III: 50 °C / 72 °C | | | 5,6 | 3,9 | 3,9 | 4,6 |
| **Installation factors; Diamond-drilling** | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | |

## Table C17.1: Displacements for metric Anchor rods / Threaded rods

| Anchor rod / Threaded rod | | M8 | M10 | M12 | M14 | M16 | M20 | M22 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Displacement-Factors for tension loading[1)]** | | | | | | | | | | | |
| **Uncracked or cracked concrete; Temperature range I, II, III** | | | | | | | | | | | |
| $\delta_{N0\text{-Factor}}$ | [mm/(N/mm²)] | 0,07 | 0,08 | 0,09 | 0,09 | 0,10 | 0,11 | 0,11 | 0,12 | 0,12 | 0,13 |
| $\delta_{N\infty\text{-Factor}}$ | | 0,11 | 0,12 | 0,13 | 0,14 | 0,15 | 0,16 | 0,17 | 0,18 | 0,19 | 0,19 |
| **Displacement-Factors for shear loading[2)]** | | | | | | | | | | | |
| **Uncracked or cracked concrete; Temperature range I, II, III** | | | | | | | | | | | |
| $\delta_{V0\text{-Factor}}$ | [mm/kN] | 0,18 | 0,15 | 0,12 | 0,10 | 0,09 | 0,07 | 0,07 | 0,06 | 0,05 | 0,05 |
| $\delta_{V\infty\text{-Factor}}$ | | 0,27 | 0,22 | 0,18 | 0,16 | 0,14 | 0,11 | 0,10 | 0,09 | 0,08 | 0,07 |

[1)] Calculation of effective displacement:

$\delta_{N0} = \delta_{N0\text{-Factor}} \cdot \tau$

$\delta_{N\infty} = \delta_{N\infty\text{-Factor}} \cdot \tau$

$\tau$ = acting bond strength under tension loading

[2)] Calculation of effective displacement:

$\delta_{V0} = \delta_{V0\text{-Factor}} \cdot V$

$\delta_{V\infty} = \delta_{V\infty\text{-Factor}} \cdot V$

V = acting shear loading

## Table C17.2: Displacements for metric fischer RG M I

| fischer RG M I | | M8 | M10 | M12 | M16 | M20 |
|---|---|---|---|---|---|---|
| **Displacement-Factors for tension loading[1)]** | | | | | | |
| **Uncracked or cracked concrete; Temperature range I, II, III** | | | | | | |
| $\delta_{N0\text{-Factor}}$ | [mm/(N/mm²)] | 0,09 | 0,10 | 0,10 | 0,11 | 0,13 |
| $\delta_{N\infty\text{-Factor}}$ | | 0,13 | 0,15 | 0,16 | 0,17 | 0,19 |
| **Displacement-Factors for shear loading[2)]** | | | | | | |
| **Uncracked or cracked concrete; Temperature range I, II, III** | | | | | | |
| $\delta_{V0\text{-Factor}}$ | [mm/kN] | 0,12 | 0,09 | 0,08 | 0,07 | 0,05 |
| $\delta_{V\infty\text{-Factor}}$ | | 0,18 | 0,14 | 0,12 | 0,10 | 0,08 |

[1)] Calculation of effective displacement:

$\delta_{N0} = \delta_{N0\text{-Factor}} \cdot \tau$

$\delta_{N\infty} = \delta_{N\infty\text{-Factor}} \cdot \tau$

$\tau$ = acting bond strength under tension loading

[2)] Calculation of effective displacement:

$\delta_{V0} = \delta_{V0\text{-Factor}} \cdot V$

$\delta_{V\infty} = \delta_{V\infty\text{-Factor}} \cdot V$

V = acting shear loading

## Table C18.1: Displacements for metric reinforcing bars

| Nominal diameter of the bar | ϕ | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 25 | 26 | 28 | 30 | 32 | 34 | 36 | 40 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Displacement-Factors for tension loading[1)]** | | | | | | | | | | | | | | | | | | |
| **Uncracked or cracked concrete; Temperature range I, II, III** | | | | | | | | | | | | | | | | | | |
| $\delta_{N0\text{-Factor}}$ | [mm/(N/mm²)] | 0,07 | 0,08 | 0,09 | 0,09 | 0,10 | 0,10 | 0,11 | 0,11 | 0,12 | 0,12 | 0,12 | 0,13 | 0,13 | 0,13 | 0,14 | 0,14 | 0,15 |
| $\delta_{N\infty\text{-Factor}}$ | | 0,11 | 0,12 | 0,13 | 0,14 | 0,15 | 0,16 | 0,16 | 0,17 | 0,18 | 0,18 | 0,18 | 0,19 | 0,19 | 0,20 | 0,20 | 0,21 | 0,22 |
| **Displacement-Factors for shear loading[2)]** | | | | | | | | | | | | | | | | | | |
| **Uncracked or cracked concrete; Temperature range I, II, III** | | | | | | | | | | | | | | | | | | |
| $\delta_{V0\text{-Factor}}$ | [mm/kN] | 0,18 | 0,15 | 0,12 | 0,10 | 0,09 | 0,08 | 0,07 | 0,07 | 0,06 | 0,06 | 0,06 | 0,05 | 0,05 | 0,05 | 0,04 | 0,04 | 0,04 |
| $\delta_{V\infty\text{-Factor}}$ | | 0,27 | 0,22 | 0,18 | 0,16 | 0,14 | 0,12 | 0,11 | 0,10 | 0,09 | 0,09 | 0,08 | 0,08 | 0,07 | 0,07 | 0,06 | 0,06 | 0,05 |

[1)] Calculation of effective displacement:

$\delta_{N0} = \delta_{N0\text{-Factor}} \cdot \tau$

$\delta_{N\infty} = \delta_{N\infty\text{-Factor}} \cdot \tau$

$\tau$ = acting bond strength under tension loading

[2)] Calculation of effective displacement:

$\delta_{V0} = \delta_{V0\text{-Factor}} \cdot V$

$\delta_{V\infty} = \delta_{V\infty\text{-Factor}} \cdot V$

V = acting shear loading

## Table C18.2: Displacements for metric fischer FRA

| fischer FRA | | M12 | M16 | M20 | M24 |
|---|---|---|---|---|---|
| **Displacement-Factors for tension loading[1)]** | | | | | |
| **Uncracked or cracked concrete; Temperature range I, II, III** | | | | | |
| $\delta_{N0\text{-Factor}}$ | [mm/(N/mm²)] | 0,09 | 0,10 | 0,11 | 0,12 |
| $\delta_{N\infty\text{-Factor}}$ | | 0,13 | 0,15 | 0,16 | 0,18 |
| **Displacement-Factors for shear loading[2)]** | | | | | |
| **Uncracked or cracked concrete; Temperature range I, II, III** | | | | | |
| $\delta_{V0\text{-Factor}}$ | [mm/kN] | 0,12 | 0,09 | 0,07 | 0,06 |
| $\delta_{V\infty\text{-Factor}}$ | | 0,18 | 0,14 | 0,11 | 0,09 |

[1)] Calculation of effective displacement:

$\delta_{N0} = \delta_{N0\text{-Factor}} \cdot \tau$

$\delta_{N\infty} = \delta_{N\infty\text{-Factor}} \cdot \tau$

$\tau$ = acting bond strength under tension loading

[2)] Calculation of effective displacement:

$\delta_{V0} = \delta_{V0\text{-Factor}} \cdot V$

$\delta_{V\infty} = \delta_{V\infty\text{-Factor}} \cdot V$

V = acting shear loading

**Table C19.1: Characteristic resistance to steel failure under tension loading for fractional Threaded rods part 1**

| Threaded rod | | | | 3/8" | 1/2" | 5/8" | 3/4" | 7/8" | 1" | 1 1/8" |
|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic resistance to steel failure under tension loading** | | | | | | | | | | |
| Characteristic resistance $N_{Rk,s}$ | Steel zinc plated | Property class | F568M, Class 5.8 | [kN] | 25,0 | 45,7 | 72,9 | 107,9 | 148,9 | 195,4 | 246,0 |
| | | | F1554, Grade 36 | | 19,9 | 36,5 | 58,3 | 86,2 | 119,1 | 156,2 | 196,7 |
| | | | F1554, Grade 55 | | 25,8 | 47,3 | 75,3 | 111,5 | 154,0 | 202,0 | 254,4 |
| | | | F1554, Grade 105 | | 43,0 | 78,8 | 125,6 | 185,9 | 256,7 | 336,8 | 424,0 |
| | | | A193, B7 | | 43,0 | 78,8 | 125,6 | 185,9 | 256,7 | 336,8 | 424,0 |
| | | | F593, Alloy Group 2 | | 34,4 | 63,0 | 100,5 | 126,4 | 174,5 | 229,0 | 288,3 |
| | Stainless steel R | | A193, Grade B8M, Class 1 | | 25,8 | 47,3 | 75,3 | 111,5 | 154,0 | 202,0 | 254,4 |
| | | | A193, Grade B8M, Class 2B | | 32,7 | 59,9 | 95,4 | 141,3 | 195,1 | 255,9 | 322,2 |
| **Partial factors** [1] | | | | | | | | | | | |
| Partial factor $\gamma_{Ms,N}$ | Steel zinc plated | Property class | F568M, Class 5.8 | [-] | 1,50 | | | | | | |
| | | | F1554, Grade 36 | | 1,94 | | | | | | |
| | | | F1554, Grade 55 | | 1,64 | | | | | | |
| | | | F1554, Grade 105 | | 1,43 | | | | | | |
| | | | A193, B7 | | 1,43 | | | | | | |
| | | | F593, Alloy Group 2 | | 1,85 | | | 2,27 | | | |
| | Stainless steel R | | A193, Grade B8M, Class 1 | | 3,00 | | | | | | |
| | | | A193, Grade B8M, Class 2B | | 1,52 | | | | | | |

[1] In absence of other national regulations.

**Table C20.1: Characteristic resistance to steel failure under shear loading for fractional Threaded rods part 2**

| Threaded rod | | | | 3/8 | 1/2" | 5/8" | 3/4" | 7/8" | 1" | 1 1/8" |
|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic resistance to steel failure under shear loading** | | | | | | | | | | |
| **without lever arm** | | | | | | | | | | |
| Characteristic resistance $V^0_{Rk,s}$ | Steel zinc plated | Property class: F568M, Class 5.8 | [kN] | 15,0 | 27,4 | 43,7 | 64,7 | 89,3 | 117,2 | 147,6 |
| | | F1554, Grade 36 | | 11,9 | 21,9 | 34,9 | 51,7 | 71,4 | 93,7 | 118,0 |
| | | F1554, Grade 55 | | 12,9 | 23,6 | 37,6 | 55,7 | 77,0 | 101,0 | 127,2 |
| | | F1554, Grade 105 | | 21,5 | 39,4 | 62,8 | 92,9 | 128,3 | 168,4 | 212,0 |
| | | A193, B7 | | 21,5 | 39,4 | 62,8 | 92,9 | 128,3 | 168,4 | 212,0 |
| | Stainless steel R | F593, Alloy Group 2 | | 17,2 | 31,5 | 50,2 | 63,2 | 87,2 | 114,5 | 144,1 |
| | | A193, Grade B8M, Class 1 | | 12,9 | 23,6 | 37,6 | 55,7 | 77,0 | 101,0 | 127,2 |
| | | A193, Grade B8M, Class 2B | | 16,3 | 29,9 | 47,7 | 70,6 | 97,5 | 127,9 | 161,1 |
| Ductility factor | | $k_6$ | [-] | 1,0 | | | | | | |
| **with lever arm** | | | | | | | | | | |
| Charact. resistance $M^0_{Rk,s}$ | Steel zinc plated | Property class: F568M, Class 5.8 | [Nm] | 29,9 | 74,0 | 148,9 | 268,2 | 435,1 | 653,8 | 923,5 |
| | | F1554, Grade 36 | | 23,9 | 59,2 | 119,1 | 214,5 | 348,0 | 522,9 | 738,6 |
| | | F1554, Grade 55 | | 30,9 | 76,6 | 154,0 | 277,4 | 450,0 | 676,1 | 955,1 |
| | | F1554, Grade 105 | | 51,5 | 127,6 | 256,8 | 462,4 | 750,0 | 1126,9 | 1591,9 |
| | | A193, B7 | | 51,5 | 127,6 | 256,8 | 462,4 | 750,0 | 1126,9 | 1591,9 |
| | Stainless steel R | F593, Alloy Group 2 | | 41,2 | 102,1 | 205,4 | 314,4 | 510,0 | 766,3 | 1082,5 |
| | | A193, Grade B8M, Class 1 | | 30,9 | 76,6 | 154,0 | 277,4 | 450,0 | 676,1 | 955,1 |
| | | A193, Grade B8M, Class 2B | | 39,1 | 97,0 | 195,1 | 351,4 | 570,0 | 856,4 | 1209,8 |
| **Partial factors** [1] | | | | | | | | | | |
| Partial factor $\gamma_{Ms,V}$ | Steel zinc plated | Property class: F568M, Class 5.8 | [-] | 1,25 | | | | | | |
| | | F1554, Grade 36 | | 1,61 | | | | | | |
| | | F1554, Grade 55 | | 1,36 | | | | | | |
| | | F1554, Grade 105 | | 1,50 | | | | | | |
| | | A193, B7 | | 1,50 | | | | | | |
| | Stainless steel R | F593, Alloy Group 2 | | 1,54 | | | 1,89 | | | |
| | | A193, Grade B8M, Class 1 | | 2,50 | | | | | | |
| | | A193, Grade B8M, Class 2B | | 1,27 | | | | | | |

[1] In absence of other national regulations.

**Table C21.1: Characteristic resistance to steel failure under tension loading for fractional fischer RG M I part 1**

| fischer RG M I | | RG M I | Screw | | 3/8" | 1/2" | 5/8" | 3/4" |
|---|---|---|---|---|---|---|---|---|
| **Characteristic resistance to steel failure under tension loading** | | | | | | | | |
| Characteristic resistance with screw $N_{Rk,s}$ | Property class, Steel zinc plated | 5.8 | F568M, Class 5.8 | [kN] | 25,0 | 45,7 | 72,9 | 107,9 |
| | | | F1554, Grade 36 | | 20,0 | 36,6 | 58,3 | 86,3 |
| | | | F1554, Grade 55 | | 25,8 | 47,3 | 75,3 | 111,5 |
| | | | F1554, Grade 105 | | 43,1 | 76,4 | 110,8 | 186,0 |
| | | | A193, B7 | | 43,1 | 76,4 | 110,8 | 186,0 |
| | Property class, Stainless steel R | 70 | F593, Alloy Group 2 | | 34,4 | 63,0 | 100,4 | 126,4 |
| | | | A193, Grade B8M, Class 1 | | 25,8 | 47,3 | 75,3 | 111,5 |
| | | | A193, Grade B8M, Class 2B | | 32,7 | 59,9 | 95,4 | 141,3 |
| **Partial factors**[1)] | | | | | | | | |
| Partial factors $\gamma_{Ms,N}$ | Property class, Steel zinc plated | 5.8 | F568M, Class 5.8 | [-] | 1,50 | | | |
| | | | F1554, Grade 36 | | 1,94 | | | |
| | | | F1554, Grade 55 | | 1,64 | | | |
| | | | F1554, Grade 105 | | 1,43 | 1,50 | | |
| | | | A193, B7 | | 1,43 | 1,50 | | |
| | Property class, Stainless steel R | 70 | F593, Alloy Group 2 | | 1,85 | | | 2,27 |
| | | | A193, Grade B8M, Class 1 | | 3,00 | | | |
| | | | A193, Grade B8M, Class 2B | | 1,52 | | | |

[1)] In absence of other national regulations.

**Table C22.1: Characteristic resistance to steel failure under shear loading for fractional fischer RG M I part 2**

| fischer RG M I | | RG M I | Screw | | 3/8" | 1/2" | 5/8" | 3/4" |
|---|---|---|---|---|---|---|---|---|
| **Characteristic resistance to steel failure under shear loading** | | | | | | | | |
| **Without lever arm** | | | | | | | | |
| Characteristic resistance with screw $V^0_{Rk,s}$ | Property class, Steel zinc plated | 5.8 | F568M, Class 5.8 | [kN] | 15,0 | 27,4 | 43,7 | 64,7 |
| | | | F1554, Grade 36 | | 11,9 | 21,9 | 34,9 | 51,7 |
| | | | F1554, Grade 55 | | 12,9 | 23,6 | 37,6 | 55,7 |
| | | | F1554, Grade 105 | | 21,5 | 39,4 | 62,8 | 92,9 |
| | | | A193, B7 | | 21,5 | 39,4 | 62,8 | 92,9 |
| | Property class, Stainless steel R | 70 | F593, Alloy Group 2 | | 17,2 | 31,5 | 50,2 | 63,2 |
| | | | A193, Grade B8M, Class 1 | | 12,9 | 23,6 | 37,6 | 55,7 |
| | | | A193, Grade B8M, Class 2B | | 16,3 | 29,9 | 47,7 | 70,6 |
| **With lever arm** | | | | | | | | |
| Characteristic resistance with screw $M^0_{Rk,s}$ | Property class, Steel zinc plated | 5.8 | F568M, Class 5.8 | [Nm] | 29,9 | 74,0 | 148,9 | 268,2 |
| | | | F1554, Grade 36 | | 23,9 | 59,2 | 119,1 | 214,5 |
| | | | F1554, Grade 55 | | 30,9 | 76,6 | 154,0 | 277,4 |
| | | | F1554, Grade 105 | | 51,5 | 127,6 | 256,8 | 462,4 |
| | | | A193, B7 | | 51,5 | 127,6 | 256,8 | 462,4 |
| | Property class, Stainless steel R | 70 | F593, Alloy Group 2 | | 41,2 | 102,1 | 205,4 | 314,4 |
| | | | A193, Grade B8M, Class 1 | | 30,9 | 76,6 | 154,0 | 277,4 |
| | | | A193, Grade B8M, Class 2B | | 39,1 | 97,0 | 195,1 | 351,4 |
| **Partial factors** [1] | | | | | | | | |
| Partial factors $\gamma_{Ms,V}$ | Property class, Steel zinc plated | 5.8 | F568M, Class 5.8 | [-] | 1,25 | | | |
| | | | F1554, Grade 36 | | 1,61 | | | |
| | | | F1554, Grade 55 | | 1,36 | | | |
| | | | F1554, Grade 105 | | 1,50 | | | |
| | | | A193, B7 | | 1,50 | | | |
| | Property class, Stainless steel R | 70 | F593, Alloy Group 2 | | 1,54 | | | 1,89 |
| | | | A193, Grade B8M, Class 1 | | 2,50 | | | |
| | | | A193, Grade B8M, Class 2B | | 1,27 | | | |

[1] In absence of other national regulations.

**Table C23.1: Characteristic restistance to steel failure under tension / shear loading for fractional reinforcing bars**

| Rebar size | | | #3 | #4 | #5 | #6 | #7 | #8 | #9 | #10[1)] |
|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic resistance to steel failure under tension loading** | | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | $A_s \cdot f_{uk}$[3)] | | | | | | | |
| **Characteristic resistance to steel failure under shear loading** | | | | | | | | | | |
| **Without lever arm** | | | | | | | | | | |
| Characteristic resistance | $V^0_{Rk,s}$ | [kN] | $k_6$[2)] $\cdot A_s \cdot f_{uk}$[3)] | | | | | | | |
| Ductility factor | $k_7$ | [-] | 1,0 | | | | | | | |
| **With lever arm** | | | | | | | | | | |
| Characteristic resistance | $M^0_{Rk,s}$ | [Nm] | $1,2 \cdot W_{el} \cdot f_{uk}$[3)] | | | | | | | |

1) Not allowed for hollow drill bit.

2) In accordance with EN 1992-4:2018 section 7.2.2.3.1:
$k_6$ = 0,6 for fasteners made of carbon steel with $f_{uk} \leq 500$ N/mm²,
= 0,5 for fasteners made of carbon steel with 500 N/mm² < $f_{uk} \leq 1000$ N/mm²,
= 0,5 for fasteners made of stainless steel.

3) $f_{uk}$ respectively shall be taken from the specifications of the reinforcing bar.

## Table C24.1: Characteristic resistance for concrete failure under tension / shear loading for fractional sizes

| Size | | | | All sizes | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic resistance to concrete failure under tension loading** | | | | | | | | | | |
| Installation factor | $\gamma_{inst}$ | [-] | | See Annex C25 to C34, C46 and C47 | | | | | | |
| **Factors for the compressive strength of concrete > C20/25** | | | | | | | | | | |
| Increasing factor $\psi_c$ for cracked or uncracked concrete $\tau_{Rk(X,Y)} = \psi_c \cdot \tau_{Rk(C20/25)}$ | C25/30 | $\Psi_c$ | [-] | 1,02 | | | | | | |
| | C30/37 | | | 1,04 | | | | | | |
| | C35/45 | | | 1,06 | | | | | | |
| | C40/50 | | | 1,07 | | | | | | |
| | C45/55 | | | 1,08 | | | | | | |
| | C50/60 | | | 1,09 | | | | | | |
| **Splitting failure** | | | | | | | | | | |
| Edge distance | $h / h_{ef} \geq 2,0$ | $c_{cr,sp}$ | [mm] | $1,0\ h_{ef}$ | | | | | | |
| | $2,0 > h / h_{ef} > 1,3$ | | | $4,6\ h_{ef} - 1,8\ h$ | | | | | | |
| | $h / h_{ef} \leq 1,3$ | | | $2,26\ h_{ef}$ | | | | | | |
| Spacing | | $s_{cr,sp}$ | | $2\ c_{cr,sp}$ | | | | | | |
| **Concrete cone failure** | | | | | | | | | | |
| Uncracked concrete | | $k_{ucr,N}$ | [-] | 11,0 | | | | | | |
| Cracked concrete | | $k_{cr,N}$ | | 7,7 | | | | | | |
| Edge distance | | $c_{cr,N}$ | [mm] | $1,5\ h_{ef}$ | | | | | | |
| Spacing | | $s_{cr,N}$ | | $2\ c_{cr,N}$ | | | | | | |
| **Factors for sustained tension loading** | | | | | | | | | | |
| Temperature range | | | | 24 °C / 40 °C | | | 35 °C / 60 °C | | 50 °C / 72 °C | |
| Factor | | $\psi^0_{sus}$ | | 0,77 | | | 0,60 | | 0,48 | |
| Factor | | $\psi^0_{sus,100}$ | | 0,77 | | | 0,60 | | 0,71 | |
| **Characteristic resistance to concrete failure under shear loading** | | | | | | | | | | |
| Installation factor | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | |
| **Concrete pry-out failure** | | | | | | | | | | |
| Factor for pry-out failure | | $k_8$ | [-] | 2,0 | | | | | | |
| **Concrete edge failure** | | | | | | | | | | |
| Effective length of fastener in shear loading | | $l_f$ | [mm] | for $d_{nom} \leq 24$ mm: min ($h_{ef}$; 12 $d_{nom}$)<br>for $d_{nom} > 24$ mm: min ($h_{ef}$; max (8 $d_{nom}$; 300 mm)) | | | | | | |
| **Calculation diameters** | | | | | | | | | | |
| Size | | | | 3/8" | 1/2" | 5/8" | 3/4" | 7/8" | 1" | 1 1/8" |
| Anchor rods and Threaded rods | | $d_{nom}$ | [mm] | 9,5 | 12,7 | 15,9 | 19,1 | 22,2 | 25,4 | 28,6 |
| fischer RG M I | | $d_{nom}$ | | 15,7 | 18,0 | 22,0 | 28,0 | -[1)] | -[1)] | -[1)] |
| Rebar size | | | | #3 | #4 | #5 | #6 | #7 | #8 | #9 | #10 |
| Reinforcing bar | | $d_{nom}$ | [mm] | 9,5 | 12,7 | 15,9 | 19,1 | 22,2 | 25,4 | 28,7 | 32,3 |

[1)] Anchor type not part of the assessment.

fischer injection system FIS EM Plus

**Performance**
Characteristic resistance for concrete failure under tension / shear loading for fractional sizes

**Annex C24**

**Table C25.1: Characteristic resistance to combined pull-out and concrete failure for fractional Threaded rods in hammer or diamond drilled holes; uncracked concrete; working life 50 years**

| Threaded rod | | | | 3/8" | 1/2" | 5/8" | 3/4" | 7/8" | 1" | 1 1/8" |
|---|---|---|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | | | | |
| Calculation diameter | | d | [mm] | 9,5 | 12,7 | 15,9 | 19,1 | 22,2 | 25,4 | 28,6 |
| **Uncracked concrete** | | | | | | | | | | |
| **Characteristic bond resistance in uncracked concrete C20/25** | | | | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 20,0 | 18,6 | 17,7 | 16,8 | 16,2 | 15,8 | 15,3 |
| | II: 35 °C / 60 °C | | | 18,0 | 18,0 | 17,0 | 16,0 | 15,0 | 15,0 | 14,0 |
| | III: 50 °C / 72 °C | | | 17,0 | 17,0 | 16,0 | 15,0 | 14,0 | 14,0 | 13,0 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 20,0 | 18,6 | 17,0 | 15,4 | 14,3 | 13,7 | 12,8 |
| | II: 35 °C / 60 °C | | | 16,0 | 15,0 | 13,0 | 11,0 | 11,0 | 10,0 | 9,0 |
| | III: 50 °C / 72 °C | | | 14,0 | 14,0 | 12,0 | 11,0 | 10,0 | 9,0 | 9,0 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | |
| Water filled hole | | | | 1,4 | | | | | | |
| Diamond-drilling (dry or wet concrete) | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 14,4 | 13,3 | 12,3 | 11,8 | 11,3 | 10,8 | 10,3 |
| | II: 35 °C / 60 °C | | | 15,0 | 13,0 | 12,0 | 10,0 | 10,0 | 9,0 | 9,0 |
| | III: 50 °C / 72 °C | | | 14,0 | 12,0 | 11,0 | 10,0 | 9,0 | 8,0 | 8,0 |
| Diamond-drilling (water filled hole) | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 17,3 | 15,0 | 13,6 | 12,4 | 11,5 | 10,8 | 10,1 |
| | II: 35 °C / 60 °C | | | 15,0 | 13,0 | 12,0 | 10,0 | 10,0 | 9,0 | 9,0 |
| | III: 50 °C / 72 °C | | | 14,0 | 12,0 | 11,0 | 10,0 | 9,0 | 8,0 | 8,0 |
| **Installation factors; Diamond-drilling** | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | |
| Water filled hole | | | | 1,4 | | | | | | |

**Table C26.1: Characteristic resistance to combined pull-out and concrete failure for fractional Threaded rods in hammer or diamond drilled holes; cracked concrete; working life 50 years**

| Threaded rod | | | | 3/8" | 1/2" | 5/8" | 3/4" | 7/8" | 1" | 1 1/8" |
|---|---|---|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | | | | |
| Calculation diameter | | d | [mm] | 9,5 | 12,7 | 15,9 | 19,1 | 22,2 | 25,4 | 28,6 |
| **Cracked concrete** | | | | | | | | | | |
| **Characteristic bond resistance in cracked concrete C20/25** | | | | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 8,7 | 9,9 | 9,5 | 8,5 | 8,5 | 8,5 | 8,5 |
| | II: 35 °C / 60 °C | | | 8,7 | 9,9 | 9,5 | 8,5 | 8,5 | 8,5 | 8,5 |
| | III: 50 °C / 72 °C | | | 8,2 | 9,3 | 8,9 | 8,5 | 8,5 | 8,5 | 8,5 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,5 | 8,5 | 7,8 | 6,0 | 6,0 | 6,0 | 6,0 |
| | II: 35 °C / 60 °C | | | 7,5 | 8,5 | 7,8 | 6,0 | 6,0 | 6,0 | 6,0 |
| | III: 50 °C / 72 °C | | | 7,0 | 8,0 | 7,3 | 6,0 | 6,0 | 6,0 | 6,0 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | |
| Water filled hole | | | | 1,2 | | | 1,4 | | | |
| Diamond-drilling (dry or wet concrete) | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,0 | 7,0 | 6,0 | 6,0 | 7,0 | 7,0 | 7,0 |
| | II: 35 °C / 60 °C | | | 7,0 | 7,0 | 6,0 | 6,0 | 7,0 | 7,0 | 7,0 |
| | III: 50 °C / 72 °C | | | 7,0 | 7,0 | 6,0 | 6,0 | 7,0 | 7,0 | 7,0 |
| Diamond-drilling (water filled hole) | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,5 | 7,5 | 6,0 | 6,0 | 6,0 | 6,0 | 6,0 |
| | II: 35 °C / 60 °C | | | 7,5 | 7,5 | 6,0 | 6,0 | 6,0 | 6,0 | 6,0 |
| | III: 50 °C / 72 °C | | | 7,0 | 7,0 | 6,0 | 6,0 | 6,0 | 6,0 | 6,0 |
| **Installation factors; Diamond-drilling** | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | |
| Water filled hole | | | | 1,2 | | | 1,4 | | | |

**Table C27.1: Characteristic resistance to combined pull-out and concrete failure for fractional Threaded rods in hammer or diamond drilled holes; uncracked concrete; working life 100 years**

| Threaded rod | | | | 3/8" | 1/2" | 5/8" | 3/4" | 7/8" | 1" | 1 1/8" |
|---|---|---|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | | | | |
| Calculation diameter | | d | [mm] | 9,5 | 12,7 | 15,9 | 19,1 | 22,2 | 25,4 | 28,6 |
| **Uncracked concrete** | | | | | | | | | | |
| **Characteristic bond resistance in uncracked concrete C20/25** | | | | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 16,4 | 15,3 | 14,5 | 13,8 | 13,3 | 12,9 | 12,6 |
| | II: 35 °C / 60 °C | | | 13,5 | 13,5 | 12,8 | 12,0 | 11,3 | 11,3 | 10,5 |
| | III: 50 °C / 72 °C | | | 10,2 | 10,2 | 10,4 | 9,8 | 9,1 | 9,1 | 8,5 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 16,4 | 15,3 | 13,9 | 12,6 | 11,7 | 11,2 | 10,5 |
| | II: 35 °C / 60 °C | | | 12,0 | 11,3 | 9,8 | 8,3 | 8,3 | 7,5 | 6,8 |
| | III: 50 °C / 72 °C | | | 8,4 | 8,4 | 7,8 | 7,2 | 6,5 | 5,9 | 5,9 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | |
| Water filled hole | | | | 1,4 | | | | | | |
| Diamond-drilling (dry or wet concrete) | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 11,8 | 10,8 | 10,1 | 9,7 | 9,3 | 8,8 | 8,5 |
| | II: 35 °C / 60 °C | | | 11,3 | 9,8 | 9,0 | 7,5 | 7,5 | 6,8 | 6,8 |
| | III: 50 °C / 72 °C | | | 8,4 | 7,2 | 7,2 | 6,5 | 5,9 | 5,2 | 5,2 |
| Diamond-drilling (water filled hole) | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 14,2 | 12,3 | 11,2 | 10,2 | 9,4 | 8,9 | 8,3 |
| | II: 35 °C / 60 °C | | | 11,3 | 9,8 | 9,0 | 7,5 | 7,5 | 6,8 | 6,8 |
| | III: 50 °C / 72 °C | | | 8,4 | 7,2 | 7,2 | 6,5 | 5,9 | 5,2 | 5,2 |
| **Installation factors; Diamond-drilling** | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | |
| Water filled hole | | | | 1,4 | | | | | | |

**Table C28.1: Characteristic resistance to combined pull-out and concrete failure for fractional Threaded rods in hammer or diamond drilled holes; cracked concrete; working life 100 years**

| Threaded rod | | | | 3/8" | 1/2" | 5/8" | 3/4" | 7/8" | 1" | 1 1/8" |
|---|---|---|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | | | | |
| Calculation diameter | | d | [mm] | 9,5 | 12,7 | 15,9 | 19,1 | 22,2 | 25,4 | 28,6 |
| **Cracked concrete** | | | | | | | | | | |
| **Characteristic bond resistance in cracked concrete C20/25** | | | | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 7,0 | 7,5 | 7,2 | 6,9 | 6,8 | 6,5 | 6,3 |
| | II: 35 °C / 60 °C | | | 7,0 | 7,5 | 7,2 | 6,9 | 6,8 | 6,5 | 6,3 |
| | III: 50 °C / 72 °C | | | 6,6 | 7,1 | 6,8 | 6,4 | 6,4 | 6,1 | 6,0 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 6,0 | 6,5 | 5,9 | 4,9 | 4,8 | 4,6 | 4,4 |
| | II: 35 °C / 60 °C | | | 6,0 | 6,5 | 5,9 | 4,9 | 4,8 | 4,6 | 4,4 |
| | III: 50 °C / 72 °C | | | 5,6 | 6,1 | 5,5 | 4,5 | 4,5 | 4,3 | 4,3 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | |
| Water filled hole | | | | 1,2 | | | 1,4 | | | |
| Diamond-drilling (dry or wet concrete) | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 6,0 | 5,6 | 3,9 | 3,9 | 4,6 | 4,6 | 4,6 |
| | II: 35 °C / 60 °C | | | 6,0 | 5,6 | 3,9 | 3,9 | 4,6 | 4,6 | 4,6 |
| | III: 50 °C / 72 °C | | | 6,0 | 5,6 | 3,9 | 3,9 | 4,6 | 4,6 | 4,6 |
| **Installation factors; Diamond-drilling** | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | |

**Table C29.1: Characteristic resistance to combined pull-out and concrete failure for fractional fischer RG M I in hammer or diamond drilled holes; uncracked concrete; working life 50 years**

| fischer RG M I | | | | 3/8" | 1/2" | 5/8" | 3/4" |
|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | |
| Calculation diameter | | d | [mm] | **15,7** | **18,0** | **22,0** | **28,0** |
| **Uncracked concrete** | | | | | | | |
| **Characteristic bond resistance in uncracked concrete C20/25** | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 17,6 | 17,0 | 16,2 | 15,3 |
| | II: 35 °C / 60 °C | | | 14,0 | 14,0 | 13,0 | 12,0 |
| | III: 50 °C / 72 °C | | | 13,0 | 13,0 | 12,0 | 11,0 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 16,9 | 15,8 | 14,3 | 12,8 |
| | II: 35 °C / 60 °C | | | 12,0 | 12,0 | 11,0 | 10,0 |
| | III: 50 °C / 72 °C | | | 12,0 | 11,0 | 10,0 | 9,0 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | |
| Water filled hole | | | | 1,4 | | | |
| Diamond-drilling (dry or wet concrete) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 12,3 | 11,9 | 11,2 | 10,4 |
| | II: 35 °C / 60 °C | | | 12,0 | 11,0 | 10,0 | 9,0 |
| | III: 50 °C / 72 °C | | | 11,0 | 10,0 | 9,0 | 8,0 |
| Diamond-drilling (water filled hole) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 13,6 | 12,6 | 11,4 | 10,2 |
| | II: 35 °C / 60 °C | | | 12,0 | 11,0 | 10,0 | 9,0 |
| | III: 50 °C / 72 °C | | | 11,0 | 10,0 | 9,0 | 8,0 |
| **Installation factors; Diamond-drilling** | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | |
| Water filled hole | | | | 1,4 | | | |

**Table C30.1: Characteristic resistance to combined pull-out and concrete failure for fractional fischer RG M I in hammer or diamond drilled holes; cracked concrete; working life 50 years**

| fischer RG M I | | | | 3/8" | 1/2" | 5/8" | 3/4" |
|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | |
| Calculation diameter | | d | [mm] | **15,7** | **18,0** | **22,0** | **28,0** |
| **Cracked concrete** | | | | | | | |
| **Characteristic bond resistance in cracked concrete C20/25** | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 6,0 | 6,0 | 7,0 | 7,0 |
| | II: 35 °C / 60 °C | | | 6,0 | 6,0 | 7,0 | 7,0 |
| | III: 50 °C / 72 °C | | | 6,0 | 6,0 | 7,0 | 7,0 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 6,5 | 6,0 | 6,0 | 6,0 |
| | II: 35 °C / 60 °C | | | 6,5 | 6,0 | 6,0 | 6,0 |
| | III: 50 °C / 72 °C | | | 6,0 | 6,0 | 6,0 | 6,0 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | |
| Water filled hole | | | | 1,2 | | 1,4 | |
| Diamond-drilling (dry or wet concrete) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 6,0 | 6,0 | 7,0 | 7,0 |
| | II: 35 °C / 60 °C | | | 6,0 | 6,0 | 7,0 | 7,0 |
| | III: 50 °C / 72 °C | | | 6,0 | 6,0 | 7,0 | 7,0 |
| Diamond-drilling (water filled hole) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 6,5 | 6,0 | 6,0 | 6,0 |
| | II: 35 °C / 60 °C | | | 6,5 | 6,0 | 6,0 | 6,0 |
| | III: 50 °C / 72 °C | | | 6,0 | 6,0 | 6,0 | 6,0 |
| **Installation factors; Diamond-drilling** | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | |
| Water filled hole | | | | 1,2 | | 1,4 | |

**Table C31.1: Characteristic resistance to combined pull-out and concrete failure for fractional fischer RG M I in hammer or diamond drilled holes; uncracked or cracked concrete; working life 100 years**

| fischer RG M I | | | | 3/8" | 1/2" | 5/8" | 3/4" |
|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | |
| Calculation diameter | | d | [mm] | **15,7** | **18,0** | **22,0** | **28,0** |
| **Uncracked concrete** | | | | | | | |
| **Characteristic bond resistance in uncracked concrete C20/25** | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 14,4 | 14,0 | 13,3 | 12,6 |
| | II: 35 °C / 60 °C | | | 10,5 | 10,5 | 9,8 | 9,0 |
| | III: 50 °C / 72 °C | | | 7,8 | 7,8 | 7,8 | 7,2 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 13,9 | 13,0 | 11,7 | 10,5 |
| | II: 35 °C / 60 °C | | | 9,0 | 9,0 | 8,3 | 7,5 |
| | III: 50 °C / 72 °C | | | 7,2 | 6,6 | 6,5 | 5,9 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | |
| Water filled hole | | | | 1,4 | | | |
| Diamond-drilling (dry or wet concrete) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 10,1 | 9,8 | 9,2 | 8,6 |
| | II: 35 °C / 60 °C | | | 9,0 | 8,3 | 7,5 | 6,8 |
| | III: 50 °C / 72 °C | | | 6,6 | 6,0 | 5,9 | 5,2 |
| Diamond-drilling (water filled hole) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 11,2 | 10,3 | 9,3 | 8,4 |
| | II: 35 °C / 60 °C | | | 9,0 | 8,3 | 7,5 | 6,8 |
| | III: 50 °C / 72 °C | | | 6,6 | 6,0 | 5,9 | 5,2 |
| **Installation factors; Diamond-drilling** | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | |
| Water filled hole | | | | 1,4 | | | |
| **Cracked concrete** | | | | | | | |
| **Characteristic bond resistance in cracked concrete C20/25** | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 5,1 | 4,8 | 4,6 | 4,6 |
| | II: 35 °C / 60 °C | | | 5,1 | 4,8 | 4,6 | 4,6 |
| | III: 50 °C / 72 °C | | | 5,1 | 4,8 | 4,6 | 4,6 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 5,5 | 4,8 | 3,9 | 3,9 |
| | II: 35 °C / 60 °C | | | 5,5 | 4,8 | 3,9 | 3,9 |
| | III: 50 °C / 72 °C | | | 5,1 | 4,8 | 3,9 | 3,9 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | |
| Water filled hole | | | | 1,2 | | 1,4 | |
| Diamond-drilling (dry or wet concrete) | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 5,1 | 4,8 | 4,6 | 4,6 |
| | II: 35 °C / 60 °C | | | 5,1 | 4,8 | 4,6 | 4,6 |
| | III: 50 °C / 72 °C | | | 5,1 | 4,8 | 4,6 | 4,6 |
| **Installation factors; Diamond-drilling** | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | |

**Table C32.1: Characteristic resistance to combined pull-out and concrete failure for fractional reinforcing bars in hammer or diamond drilled holes; uncracked concrete; working life 50 years**

| Rebar size | | | | #3 | #4 | #5 | #6 | #7 | #8 | #9 | #10[1)] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | | | | | |
| Calculation diameter | | d | [mm] | 9,5 | 12,7 | 15,9 | 19,1 | 22,2 | 25,4 | 28,7 | 32,3 |
| **Uncracked concrete** | | | | | | | | | | | |
| **Characteristic bond resistance in uncracked concrete C20/25** | | | | | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 17,0 | 15,9 | 15,1 | 14,4 | 13,9 | 13,4 | 13,1 | 12,7 |
| | II: 35 °C / 60 °C | | | 15,0 | 15,0 | 14,0 | 13,0 | 13,0 | 12,0 | 12,0 | 12,0 |
| | III 50 °C / 72 °C | | | 14,0 | 14,0 | 13,0 | 12,0 | 12,0 | 11,0 | 11,0 | 11,0 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 17,0 | 15,9 | 14,5 | 13,2 | 12,3 | 11,6 | 10,5 | 10,2 |
| | II: 35 °C / 60 °C | | | 16,0 | 14,0 | 12,0 | 11,0 | 11,0 | 10,0 | 10,0 | 9,0 |
| | III 50 °C / 72 °C | | | 14,0 | 13,0 | 12,0 | 11,0 | 10,0 | 9,0 | 9,0 | 8,0 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |
| Water filled hole | | | | 1,4 | | | | | | | |
| Diamond-drilling (dry or wet concrete as well as water filled hole) | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 15,0 | 13,0 | 12,0 | 10,0 | 10,0 | 9,0 | 9,0 | 8,0 |
| | II: 35 °C / 60 °C | | | 15,0 | 13,0 | 12,0 | 10,0 | 10,0 | 9,0 | 9,0 | 8,0 |
| | III 50 °C / 72 °C | | | 14,0 | 12,0 | 11,0 | 10,0 | 9,0 | 9,0 | 8,0 | 8,0 |
| **Installation factors; Diamond-drilling** | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |
| Water filled hole | | | | 1,4 | | | | | | | |

[1)] Not allowed for drilling with hollow drill bit.

**Table C33.1: Characteristic resistance to combined pull-out and concrete failure for fractional reinforcing bars in hammer or diamond drilled holes; cracked concrete; working life 50 years**

| Rebar size | | | #3 | #4 | #5 | #6 | #7 | #8 | #9 | #10[1)] |
|---|---|---|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | | | | |
| Calculation diameter | d | [mm] | 9,5 | 12,7 | 15,9 | 19,1 | 22,2 | 25,4 | 28,7 | 32,3 |
| **Cracked concrete** | | | | | | | | | | |
| **Characteristic bond resistance in cracked concrete C20/25** | | | | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | | | | |
| Temperature range I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 |
| Temperature range II: 35 °C / 60 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 |
| Temperature range III 50 °C / 72 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 | 8,0 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | | | | |
| Temperature range I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,5 | 6,5 | 6,5 | 6,0 | 6,0 | 6,0 | 6,0 | 5,0 |
| Temperature range II: 35 °C / 60 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,5 | 6,5 | 6,5 | 6,0 | 6,0 | 6,0 | 6,0 | 5,0 |
| Temperature range III 50 °C / 72 °C | $\tau_{Rk,cr}$ | [N/mm²] | 6,5 | 6,5 | 6,0 | 6,0 | 6,0 | 6,0 | 6,0 | 5,0 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | | | | |
| Dry or wet concrete | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |
| Water filled hole | $\gamma_{inst}$ | [-] | 1,2 | | | 1,4 | | | | |
| Diamond-drilling (dry or wet concrete) | | | | | | | | | | |
| Temperature range I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,0 | 7,0 | 6,0 | 6,0 | 7,0 | 7,0 | 7,0 | 5,0 |
| Temperature range II: 35 °C / 60 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,0 | 7,0 | 6,0 | 6,0 | 7,0 | 7,0 | 7,0 | 5,0 |
| Temperature range III 50 °C / 72 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,0 | 7,0 | 6,0 | 6,0 | 7,0 | 7,0 | 7,0 | 5,0 |
| Diamond-drilling (water filled hole) | | | | | | | | | | |
| Temperature range I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,5 | 6,5 | 6,5 | 6,0 | 6,0 | 6,0 | 6,0 | 5,0 |
| Temperature range II: 35 °C / 60 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,5 | 6,5 | 6,5 | 6,0 | 6,0 | 6,0 | 6,0 | 5,0 |
| Temperature range III 50 °C / 72 °C | $\tau_{Rk,cr}$ | [N/mm²] | 6,5 | 6,5 | 6,0 | 6,0 | 6,0 | 6,0 | 6,0 | 5,0 |
| **Installation factors; Diamond-drilling** | | | | | | | | | | |
| Dry or wet concrete | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |
| Water filled hole | $\gamma_{inst}$ | [-] | 1,2 | | | 1,4 | | | | |

[1)] Not allowed for drilling with hollow drill bit.

**Table C34.1: Characteristic resistance to combined pull-out and concrete failure for fractional reinforcing bars in hammer or diamond drilled holes; uncracked and cracked concrete; working life 100 years**

| Rebar size | | | | #3 | #4 | #5 | #6 | #7 | #8 | #9 | #10[1)] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Combined pull-out and concrete cone failure** | | | | | | | | | | | |
| Calculation diameter | | d | [mm] | 9,5 | 12,7 | 15,9 | 19,1 | 22,2 | 25,4 | 28,7 | 32,3 |
| **Uncracked concrete** | | | | | | | | | | | |
| **Characteristic bond resistance in uncracked concrete C20/25** | | | | | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 14,0 | 13,0 | 12,4 | 11,9 | 11,4 | 11,0 | 10,8 | 10,5 |
| | II: 35 °C / 60 °C | | | 11,3 | 11,3 | 10,5 | 9,8 | 9,8 | 9,0 | 9,0 | 9,0 |
| | III 50 °C / 72 °C | | | 8,4 | 8,4 | 8,5 | 7,8 | 7,8 | 7,2 | 7,2 | 7,2 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 13,9 | 13,0 | 11,9 | 11,0 | 10,1 | 9,5 | 8,6 | 8,5 |
| | II: 35 °C / 60 °C | | | 12,0 | 10,5 | 9,0 | 8,3 | 8,3 | 7,5 | 7,5 | 6,8 |
| | III 50 °C / 72 °C | | | 8,4 | 7,8 | 7,8 | 7,2 | 6,5 | 5,9 | 5,9 | 5,2 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |
| Water filled hole | | | | 1,4 | | | | | | | |
| Diamond-drilling (dry or wet concrete as well as water filled hole) | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,ucr}$ | [N/mm²] | 11,3 | 9,8 | 9,0 | 7,5 | 7,5 | 6,8 | 6,8 | 6,0 |
| | II: 35 °C / 60 °C | | | 11,3 | 9,8 | 9,0 | 7,5 | 7,5 | 6,8 | 6,8 | 6,0 |
| | III 50 °C / 72 °C | | | 8,4 | 7,2 | 7,2 | 6,5 | 5,9 | 5,9 | 5,2 | 5,2 |
| **Installation factors** | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |
| Water filled hole | | | | 1,4 | | | | | | | |
| **Cracked concrete** | | | | | | | | | | | |
| **Characteristic bond resistance in cracked concrete C20/25** | | | | | | | | | | | |
| Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete) | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 6,0 | 6,4 | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 |
| | II: 35 °C / 60 °C | | | 6,0 | 6,4 | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 |
| | III 50 °C / 72 °C | | | 6,0 | 6,4 | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 | 5,2 |
| Hammer-drilling with standard drill bit or hollow drill bit (water filled hole) | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,100,cr}$ | [N/mm²] | 6,4 | 5,2 | 4,2 | 3,9 | 3,9 | 3,9 | 3,9 | 3,3 |
| | II: 35 °C / 60 °C | | | 6,4 | 5,2 | 4,2 | 3,9 | 3,9 | 3,9 | 3,9 | 3,3 |
| | III 50 °C / 72 °C | | | 5,5 | 5,2 | 3,9 | 3,9 | 3,9 | 3,9 | 3,9 | 3,3 |
| **Installation factors; Hammer-drilling with standard drill bit or hollow drill bit** | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |
| Water filled hole | | | | 1,2 | | | 1,4 | | | | |
| Diamond-drilling (dry or wet concrete) | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,cr}$ | [N/mm²] | 6,0 | 5,6 | 3,9 | 3,9 | 4,6 | 4,6 | 4,6 | 3,3 |
| | II: 35 °C / 60 °C | | | 6,0 | 5,6 | 3,9 | 3,9 | 4,6 | 4,6 | 4,6 | 3,3 |
| | III 50 °C / 72 °C | | | 6,0 | 5,6 | 3,9 | 3,9 | 4,6 | 4,6 | 4,6 | 3,3 |
| **Installation factors** | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |

[1)] Not allowed for drilling with hollow drill bit.

## Table C35.1: Displacements for fraction Threaded rods

| Threaded rod | | 3/8" | 1/2" | 5/8" | 3/4" | 7/8" | 1" | 1 1/8" |
|---|---|---|---|---|---|---|---|---|
| **Displacement-Factors for tension loading[1)]** | | | | | | | | |
| **Uncracked or cracked concrete; Temperature range I, II, III** | | | | | | | | |
| $\delta_{N0\text{-Factor}}$ | [mm/(N/mm²)] | 0,08 | 0,09 | 0,10 | 0,11 | 0,11 | 0,12 | 0,13 |
| $\delta_{N\infty\text{-Factor}}$ | | 0,12 | 0,13 | 0,15 | 0,16 | 0,17 | 0,19 | 0,19 |
| **Displacement-Factors for shear loading[2)]** | | | | | | | | |
| **Uncracked or cracked concrete; Temperature range I, II, III** | | | | | | | | |
| $\delta_{V0\text{-Factor}}$ | [mm/kN] | 0,15 | 0,12 | 0,09 | 0,07 | 0,07 | 0,05 | 0,05 |
| $\delta_{V\infty\text{-Factor}}$ | | 0,22 | 0,18 | 0,14 | 0,11 | 0,10 | 0,08 | 0,07 |

[1)] Calculation of effective displacement:

$\delta_{N0} = \delta_{N0\text{-Factor}} \cdot \tau$

$\delta_{N\infty} = \delta_{N\infty\text{-Factor}} \cdot \tau$

$\tau$ = acting bond strength under tension loading

[2)] Calculation of effective displacement:

$\delta_{V0} = \delta_{V0\text{-Factor}} \cdot V$

$\delta_{V\infty} = \delta_{V\infty\text{-Factor}} \cdot V$

V = acting shear loading

## Table C35.2: Displacements for fractional fischer RG M I

| fischer RG M I | | 3/8" | 1/2" | 5/8" | 3/4" |
|---|---|---|---|---|---|
| **Displacement-Factors for tension loading[1)]** | | | | | |
| **Uncracked or cracked concrete; Temperature range I, II, III** | | | | | |
| $\delta_{N0\text{-Factor}}$ | [mm/(N/mm²)] | 0,10 | 0,10 | 0,11 | 0,13 |
| $\delta_{N\infty\text{-Factor}}$ | | 0,15 | 0,16 | 0,17 | 0,19 |
| **Displacement-Factors for shear loading[2)]** | | | | | |
| **Uncracked or cracked concrete; Temperature range I, II, III** | | | | | |
| $\delta_{V0\text{-Factor}}$ | [mm/kN] | 0,09 | 0,08 | 0,07 | 0,05 |
| $\delta_{V\infty\text{-Factor}}$ | | 0,14 | 0,12 | 0,10 | 0,08 |

[1)] Calculation of effective displacement:

$\delta_{N0} = \delta_{N0\text{-Factor}} \cdot \tau$

$\delta_{N\infty} = \delta_{N\infty\text{-Factor}} \cdot \tau$

$\tau$ = acting bond strength under tension loading

[2)] Calculation of effective displacement:

$\delta_{V0} = \delta_{V0\text{-Factor}} \cdot V$

$\delta_{V\infty} = \delta_{V\infty\text{-Factor}} \cdot V$

V = acting shear loading

## Table C36.1: Displacements for fractional reinforcing bars

| Rebar size | | #3 | #4 | #5 | #6 | #7 | #8 | #9 | #10 |
|---|---|---|---|---|---|---|---|---|---|
| **Displacement-Factors for tension loading[1)]** | | | | | | | | | |
| **Uncracked or cracked concrete; Temperature range I, II, III** | | | | | | | | | |
| $\delta_{N0\text{-Factor}}$ | [mm/(N/mm²)] | 0,08 | 0,09 | 0,10 | 0,11 | 0,11 | 0,12 | 0,13 | 0,13 |
| $\delta_{N\infty\text{-Factor}}$ | | 0,12 | 0,13 | 0,15 | 0,16 | 0,17 | 0,18 | 0,19 | 0,20 |
| **Displacement-Factors for shear loading[2)]** | | | | | | | | | |
| **Uncracked or cracked concrete; Temperature range I, II, III** | | | | | | | | | |
| $\delta_{V0\text{-Factor}}$ | [mm/kN] | 0,15 | 0,12 | 0,09 | 0,07 | 0,07 | 0,06 | 0,05 | 0,05 |
| $\delta_{V\infty\text{-Factor}}$ | | 0,22 | 0,18 | 0,14 | 0,11 | 0,10 | 0,09 | 0,08 | 0,07 |

[1)] Calculation of effective displacement:

$\delta_{N0} = \delta_{N0\text{-Factor}} \cdot \tau$

$\delta_{N\infty} = \delta_{N\infty\text{-Factor}} \cdot \tau$

$\tau$ = acting bond strength under tension loading

[2)] Calculation of effective displacement:

$\delta_{V0} = \delta_{V0\text{-Factor}} \cdot V$

$\delta_{V\infty} = \delta_{V\infty\text{-Factor}} \cdot V$

V = acting shear loading

**Table C37.1: Characteristic resistance to steel failure under tension / shear loading for metric Anchor rods and Threaded rods under seismic action performance category C1**

| Anchor rod / Threaded rod | | | | M10 | M12 | M14 | M16 | M20 | M22 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic resistance to steel failure under tension loading [1)]** | | | | | | | | | | | | |
| **Anchor rods and Threaded rods, performance category C1[2)]** | | | | | | | | | | | | |
| Characteristic resistance $N_{Rk,s,C1}$ | Steel zinc plated | Property class | 4.8 | [kN] | 23,2(21,4) | 33,7 | 46,0 | 62,8 | 98,0 | 121,2 | 141,2 | 183,6 | 224,4 |
| | | | 5.8 | | 29,0(26,8) | 42,1 | 57,5 | 78,5 | 122,5 | 151,5 | 176,5 | 229,5 | 280,5 |
| | | | 8.8 | | 46,4(42,8) | 67,4 | 92,0 | 125,6 | 196,0 | 242,4 | 282,4 | 367,2 | 448,8 |
| | Stainless steel R and high corrosion resistant steel HCR | | 50 | | 29,0 | 42,1 | 57,5 | 78,5 | 122,5 | 151,5 | 176,5 | 229,5 | 280,5 |
| | | | 70 | | 40,6 | 59,0 | 80,5 | 109,9 | 171,5 | 212,1 | 247,1 | 321,3 | 392,7 |
| | | | 80 | | 46,4 | 67,4 | 92,0 | 125,6 | 196,0 | 242,4 | 282,4 | 367,2 | 448,8 |
| **Characteristic resistance to steel failure under shear loading without lever arm [1)]** | | | | | | | | | | | | |
| **Anchor rods, performance category C1[2)]** | | | | | | | | | | | | |
| Characteristic resistance $V_{Rks,C1}$ | Steel zinc plated | Property class | 4.8 | [kN] | 13,9(12,8) | 20,2 | 27,6 | 37,6 | 58,8 | 72,7 | 84,7 | 110,1 | 134,6 |
| | | | 5.8 | | 17,4(16,0) | 25,2 | 34,5 | 47,1 | 73,5 | 90,9 | 105,9 | 137,7 | 168,3 |
| | | | 8.8 | | 23,2(21,4) | 33,7 | 46,0 | 62,8 | 98,0 | 121,2 | 141,2 | 183,6 | 224,4 |
| | Stainless steel R and high corrosion resistant steel HCR | | 50 | | 14,5 | 21,0 | 28,7 | 39,2 | 61,2 | 75,7 | 88,2 | 114,7 | 140,2 |
| | | | 70 | | 20,3 | 29,5 | 40,2 | 54,9 | 85,7 | 106,0 | 123,5 | 160,6 | 196,3 |
| | | | 80 | | 23,2 | 33,7 | 46,0 | 62,8 | 98,0 | 121,2 | 141,2 | 183,6 | 224,4 |
| **Threaded rods, performance category C1[2)]** | | | | | | | | | | | | |
| Characteristic resistance $V_{Rk,s,C1}$ | Steel zinc plated | Property class | 4.8 | [kN] | 9,7(9,0) | 14,1 | 19,3 | 26,3 | 41,1 | 50,9 | 59,3 | 77,1 | 97,2 |
| | | | 5.8 | | 12,1(11,2) | 17,7 | 24,1 | 32,9 | 51,4 | 63,6 | 74,1 | 96,3 | 117,8 |
| | | | 8.8 | | 16,2(15,0) | 23,6 | 32,2 | 43,9 | 68,6 | 84,8 | 98,8 | 128,5 | 157,0 |
| | Stainless steel R and high corrosion resistant steel HCR | | 50 | | 10,1 | 14,7 | 20,1 | 27,4 | 42,8 | 53,0 | 61,7 | 80,3 | 98,1 |
| | | | 70 | | 14,2 | 20,6 | 28,1 | 38,4 | 60,0 | 74,2 | 86,4 | 112,4 | 137,4 |
| | | | 80 | | 16,2 | 23,6 | 32,2 | 43,9 | 68,6 | 84,8 | 98,8 | 128,5 | 157,0 |

[1)] Partial factors for performance category C1 or C2 see table C39.1; for Anchor rods the factor for steel ductility is 1,0.

[2)] Values in brackets are valid for undersized Threaded rods with smaller stress area $A_s$ for hot dip galvanised Threaded rods according to EN ISO 10684:2004+AC:2009.

**Table C38.1: Characteristic resistance to steel failure under tension / shear loading for metric Anchor rods and Threaded rods under seismic action performance category C2**

| Anchor rod / Threaded rod | | | | M10 | M12 | M14 | M16 | M20 | M22 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic resistance to steel failure under tension loading [1)]** | | | | | | | | | | | | |
| **Anchor rods and Threaded rods, performance category C2** | | | | | | | | | | | | |
| Characteristic resistance $N_{Rk,s,C2}$ | Steel zinc plated | Property class | 4.8 | [kN] | -[2)] | 30,3 | -[2)] | 56,5 | 88,2 | -[2)] | 141,2 | -[2)] | -[2)] |
| | | | 5.8 | | -[2)] | 37,9 | -[2)] | 70,6 | 110,2 | -[2)] | 176,5 | -[2)] | -[2)] |
| | | | 8.8 | | -[2)] | 60,6 | -[2)] | 113,0 | 176,4 | -[2)] | 282,4 | -[2)] | -[2)] |
| | Stainless steel R and high corrosion resistant steel HCR | | 50 | | -[2)] | 37,9 | -[2)] | 70,6 | 110,2 | -[2)] | 176,5 | -[2)] | -[2)] |
| | | | 70 | | -[2)] | 53,1 | -[2)] | 98,9 | 154,3 | -[2)] | 247,1 | -[2)] | -[2)] |
| | | | 80 | | -[2)] | 60,6 | -[2)] | 113,0 | 176,4 | -[2)] | 282,4 | -[2)] | -[2)] |
| **Characteristic resistance to steel failure under shear loading without lever arm [1)]** | | | | | | | | | | | | |
| **Anchor rods, performance category C2** | | | | | | | | | | | | |
| Characteristic resistance $V_{Rks,C2}$ | Steel zinc plated | Property class | 4.8 | [kN] | -[2)] | 13,3 | -[2)] | 28,2 | 45,2 | -[2)] | 77,0 | -[2)] | -[2)] |
| | | | 5.8 | | -[2)] | 16,6 | -[2)] | 35,3 | 56,5 | -[2)] | 96,3 | -[2)] | -[2)] |
| | | | 8.8 | | -[2)] | 22,2 | -[2)] | 47,1 | 75,4 | -[2)] | 128,4 | -[2)] | -[2)] |
| | Stainless steel R and high corrosion resistant steel HCR | | 50 | | -[2)] | 13,9 | -[2)] | 29,4 | 47,1 | -[2)] | 80,3 | -[2)] | -[2)] |
| | | | 70 | | -[2)] | 19,4 | -[2)] | 41,2 | 66,0 | -[2)] | 112,4 | -[2)] | -[2)] |
| | | | 80 | | -[2)] | 22,2 | -[2)] | 47,1 | 75,4 | -[2)] | 128,4 | -[2)] | -[2)] |
| **Threaded rods, performance category C2** | | | | | | | | | | | | |
| Characteristic resistance $V_{Rk,s,C2}$ | Steel zinc plated | Property class | 4.8 | [kN] | -[2)] | 14,1 | -[2)] | 26,3 | 41,1 | -[2)] | 59,3 | -[2)] | -[2)] |
| | | | 5.8 | | -[2)] | 17,7 | -[2)] | 32,9 | 51,4 | -[2)] | 74,1 | -[2)] | -[2)] |
| | | | 8.8 | | -[2)] | 23,6 | -[2)] | 43,9 | 68,6 | -[2)] | 98,8 | -[2)] | -[2)] |
| | Stainless steel R and high corrosion resistant steel HCR | | 50 | | -[2)] | 14,7 | -[2)] | 27,4 | 42,8 | -[2)] | 61,7 | -[2)] | -[2)] |
| | | | 70 | | -[2)] | 20,6 | -[2)] | 38,4 | 60,0 | -[2)] | 86,4 | -[2)] | -[2)] |
| | | | 80 | | -[2)] | 23,6 | -[2)] | 43,9 | 68,6 | -[2)] | 98,8 | -[2)] | -[2)] |

[1)] Partial factors for performance category C2 see table C39.1; for Anchor rods the factor for steel ductility is 1,0.
[2)] No performance assessed.

**Table C38.2: Characteristic resistance to steel failure under tension / shear loading for metric reinforcing bars (B500B) under seismic action performance category C1**

| Nominal diameter of the bar | | | ϕ | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 25 | 26 | 28 | 30 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic resistance to steel failure under tension loading [1)]** | | | | | | | | | | | | | | | | |
| **Reinforcing bar B500B acc. to DIN 488-2:2009-08, performance category C1** | | | | | | | | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s,C1}$ | [kN] | | 42,3 | 61,0 | 83,1 | 108,5 | 137,1 | 169,5 | 205,2 | 244,0 | 265,1 | 286,2 | 332,6 | 381,2 | 434,1 |
| **Characteristic resistance to steel failure under shear loading, without lever arm[1)]** | | | | | | | | | | | | | | | | |
| **Reinforcing bar B500B acc. to DIN 488-2:2009-08, performance category C1** | | | | | | | | | | | | | | | | |
| Characteristic resistance | $V_{Rk,s,C1}$ | [kN] | | 14,8 | 21,3 | 29,1 | 37,9 | 48,0 | 59,3 | 71,8 | 85,4 | 92,7 | 100,1 | 116,4 | 133,4 | 151,9 |

[1)] Partial factors for performance category C1 see table C39.1.

**Table C39.1: Partial factors for metric Anchor rods, Threaded rods and reinforcing bars (B500B) under seismic action performance category C1 or C2**

| Anchor rod / Threaded rod | | | | M10 to M30 |
|---|---|---|---|---|
| Nominal diameter of the bar | | | ϕ | 10 to 32 |
| **Tension loading, steel failure[3)]** | | | | |
| Partial factor $\gamma_{Ms,N}$ | Steel zinc plated | Property class 5.8 | [-] | 1,50 |
| | | Property class 8.8 | | 1,50 |
| | Stainless steel R and high corrosion resistant steel HCR | Property class 50 | | 2,86 |
| | | Property class 70 | | 1,87 / Anchor rod HCR: 1,50 |
| | | Property class 80 | | 1,60 |
| | Reinforcing bar | B500B | | 1,40 |
| **Shear loading, steel failure[3)]** | | | | |
| Partial factor $\gamma_{Ms,V}$ | Steel zinc plated | Property class 5.8 | [-] | 1,25 |
| | | Property class 8.8 | | 1,25 |
| | Stainless steel R and high corrosion resistant steel HCR | Property class 50 | | 2,38 |
| | | Property class 70 | | 1,56 / Anchor rod HCR: 1,25[2)] |
| | | Property class 80 | | 1,33 |
| | Reinforcing bar | B500B | | 1,50 |

[1)] Anchor type not part of the assessment.
[2)] Only admissible for high corrosion resistant steel HCR, with $f_{yk} / f_{uk} \geq 0,8$ and $A_5 > 12$ % (e.g. Anchor rods).
[3)] In absence of other national regulations.

**Table C40.1: Characteristic resistance for combined pull-out and concrete failure for metric Anchor rods and Threaded rods in hammer drilled holes under seismic action performance category C1; working life 50 years**

| Anchor rod / Threaded rod | | | | M10 | M12 | M14 | M16 | M20 | M22 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic bond resistance, combined pull-out and concrete cone failure** | | | | | | | | | | | | |
| **Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete)** | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,C1}$ | [N/mm²] | 7,0 | 7,0 | 6,7 | 6,0 | 5,7 | 6,7 | 6,7 | 6,7 | 6,7 |
| | II: 35 °C / 60 °C | | | 7,0 | 7,0 | 6,7 | 6,0 | 5,7 | 6,7 | 6,7 | 6,7 | 6,7 |
| | III: 50 °C / 72 °C | | | 7,0 | 7,0 | 6,7 | 5,7 | 5,7 | 6,7 | 6,7 | 6,7 | 6,7 |
| **Hammer-drilling with standard drill bit or hollow drill bit (water filled hole)** | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,C1}$ | [N/mm²] | 7,5 | 7,5 | 6,5 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 |
| | II: 35 °C / 60 °C | | | 7,5 | 7,5 | 6,5 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 |
| | III: 50 °C / 72 °C | | | 6,8 | 6,8 | 6,5 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 |
| **Installation factors** | | | | | | | | | | | | |
| **Tension loading** | | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | |
| Water filled hole | | | | 1,2 | | | | 1,4 | | | | |

**Table C40.2: Characteristic resistance for combined pull-out and concrete failure for metric Anchor rods and Threaded rods in hammer drilled holes under seismic action performance category C1; working life 100 years**

| Anchor rod / Threaded rod | | | | M10 | M12 | M14 | M16 | M20 | M22 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic bond resistance, combined pull-out and concrete cone failure** | | | | | | | | | | | | |
| **Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete)** | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,C1}$ | [N/mm²] | 5,5 | 5,3 | 5,8 | 4,6 | 4,6 | 5,4 | 5,3 | 5,1 | 5,0 |
| | II: 35 °C / 60 °C | | | 5,5 | 5,3 | 5,8 | 4,6 | 4,6 | 5,4 | 5,3 | 5,1 | 5,0 |
| | III: 50 °C / 72 °C | | | 5,5 | 5,3 | 5,5 | 4,3 | 4,3 | 5,0 | 5,0 | 4,8 | 4,8 |
| **Hammer-drilling with standard drill bit or hollow drill bit (water filled hole)** | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,C1}$ | [N/mm²] | 5,9 | 5,6 | 5,7 | 4,3 | 4,6 | 4,6 | 4,5 | 4,3 | 4,2 |
| | II: 35 °C / 60 °C | | | 5,9 | 5,6 | 5,7 | 4,3 | 4,6 | 4,6 | 4,5 | 4,3 | 4,2 |
| | III: 50 °C / 72 °C | | | 5,3 | 5,1 | 5,3 | 4,3 | 4,3 | 4,3 | 4,2 | 4,1 | 4,0 |
| **Installation factors** | | | | | | | | | | | | |
| **Tension loading** | | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | |
| Water filled hole | | | | 1,2 | | | | 1,4 | | | | |

**Table C41.1: Characteristic resistance** for **combined pull-out** and **concrete failure** for **metric reinforcing bars** in hammer drilled holes under seismic action performance category **C1; working life 50 years**

| **Nominal diameter of the bar** | | **ϕ** | **10** | **12** | **14** | **16** | **18** | **20** | **22** | **24** | **25** | **26** | **28** | **30** | **32** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic bond resistance, combined pull-out and concrete cone failure** | | | | | | | | | | | | | | | |
| **Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete)** | | | | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,C1}$ [N/mm²] | 7,0 | 7,0 | 6,7 | 5,7 | 5,7 | 5,7 | 6,7 | 6,7 | 6,7 | 6,7 | 6,7 | 6,7 | 4,8 |
| | II: 35 °C / 60 °C | | 7,0 | 7,0 | 6,7 | 5,7 | 5,7 | 5,7 | 6,7 | 6,7 | 6,7 | 6,7 | 6,7 | 6,7 | 4,8 |
| | III: 50 °C / 72 °C | | 7,0 | 7,0 | 6,7 | 5,7 | 5,7 | 5,7 | 6,7 | 6,7 | 6,7 | 6,7 | 6,7 | 6,7 | 4,8 |
| **Hammer-drilling with standard drill bit or hollow drill bit (water filled hole)** | | | | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,C1}$ [N/mm²] | 7,5 | 6,5 | 6,5 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 4,8 |
| | II: 35 °C / 60 °C | | 7,5 | 6,5 | 6,5 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 4,8 |
| | III: 50 °C / 72 °C | | 6,5 | 6,5 | 5,8 | 5,8 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 4,8 |
| **Installation factors** | | | | | | | | | | | | | | | |
| **Tension loading** | | | | | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ [-] | 1,0 | | | | | | | | | | | | |
| Water filled hole | | | 1,2 | | | | | 1,4 | | | | | | | |

**Table C41.2: Characteristic resistance** for **combined pull-out** and **concrete failure** for **metric reinforcing bars** in hammer drilled holes under seismic action performance category **C1; working life 100 years**

| **Nominal diameter of the bar** | | **ϕ** | **10** | **12** | **14** | **16** | **18** | **20** | **22** | **24** | **25** | **26** | **28** | **30** | **32** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic bond resistance, combined pull-out and concrete cone failure** | | | | | | | | | | | | | | | |
| **Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete)** | | | | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,C1}$ [N/mm²] | 6,0 | 5,6 | 4,4 | 3,7 | 3,7 | 3,7 | 4,4 | 4,4 | 4,4 | 4,4 | 4,4 | 4,4 | 3,1 |
| | II: 35 °C / 60 °C | | 6,0 | 5,6 | 4,4 | 3,7 | 3,7 | 3,7 | 4,4 | 4,4 | 4,4 | 4,4 | 4,4 | 4,4 | 3,1 |
| | III: 50 °C / 72 °C | | 6,0 | 5,6 | 4,4 | 3,7 | 3,7 | 3,7 | 4,4 | 4,4 | 4,4 | 4,4 | 4,4 | 4,4 | 3,1 |
| **Hammer-drilling with standard drill bit or hollow drill bit (water filled hole)** | | | | | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,C1}$ [N/mm²] | 6,4 | 5,2 | 4,2 | 3,7 | 3,7 | 3,7 | 3,7 | 3,7 | 3,7 | 3,7 | 3,7 | 3,7 | 3,1 |
| | II: 35 °C / 60 °C | | 6,4 | 5,2 | 4,2 | 3,7 | 3,7 | 3,7 | 3,7 | 3,7 | 3,7 | 3,7 | 3,7 | 3,7 | 3,1 |
| | III: 50 °C / 72 °C | | 5,5 | 5,2 | 3,8 | 3,8 | 3,7 | 3,7 | 3,7 | 3,7 | 3,7 | 3,7 | 3,7 | 3,7 | 3,1 |
| **Installation factors** | | | | | | | | | | | | | | | |
| **Tension loading** | | | | | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ [-] | 1,0 | | | | | | | | | | | | |
| Water filled hole | | | 1,2 | | | | | 1,4 | | | | | | | |

**Table C42.1:** Characteristic **resistance** for **combined pull-out** and **concrete failure** for **metric Anchor rods** and **Threaded rods** in hammer drilled holes under seismic action performance category **C2; working life 50 and 100 years**

| Anchor rod / Threaded rod | | | | M12 | M16 | M20 | M24 |
|---|---|---|---|---|---|---|---|
| **Characteristic bond resistance, combined pull-out and concrete cone failure** | | | | | | | |
| **Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete)** | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,C2}$ | [N/mm²] | 3,5 | 5,8 | 5,0 | 3,1 |
| | II: 35 °C / 60 °C | | | 3,5 | 5,8 | 5,0 | 3,1 |
| | III: 50 °C / 72 °C | | | 3,3 | 5,5 | 4,7 | 2,9 |
| **Hammer-drilling with standard drill bit or hollow drill bit (water filled hole)** | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,C2}$ | [N/mm²] | 3,5 | 5,8 | 5,0 | 3,1 |
| | II: 35 °C / 60 °C | | | 3,5 | 5,8 | 5,0 | 3,1 |
| | III: 50 °C / 72 °C | | | 3,3 | 5,5 | 4,7 | 2,9 |
| **Installation factors** | | | | | | | |
| **Tension loading** | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | |
| Water filled hole | | | | 1,2 | | 1,4 | |
| **Displacement-Factors for tension loading[1)]** | | | | | | | |
| $\delta_{N,C2(50\%)}$-Factor | | [mm/(N/mm²)] | | 0,09 | 0,10 | 0,11 | 0,12 |
| $\delta_{N,C2(100\%)}$-Factor | | | | 0,15 | 0,17 | 0,17 | 0,18 |
| **Displacement-Factors for shear loading[2)]** | | | | | | | |
| $\delta_{V,C2(50\%)}$-Factor | | [mm/kN] | | 0,18 | 0,10 | 0,07 | 0,06 |
| $\delta_{V,C2(100\%)}$-Factor | | | | 0,25 | 0,14 | 0,11 | 0,09 |

[1)] Calculation of effective displacement:

$\delta_{N,C2(50\%)} = \delta_{N,C2(50\%)\text{-Factor}} \cdot \tau$

$\delta_{N,C2(100\%)} = \delta_{N,C2(100\%)\text{-Factor}} \cdot \tau$

$\tau$ = acting bond strength under tension loading

[2)] Calculation of effective displacement:

$\delta_{V,C2(50\%)} = \delta_{V,C2(50\%)\text{-Factor}} \cdot V$

$\delta_{V,C2(100\%)} = \delta_{V,C2(100\%)\text{-Factor}} \cdot V$

V = acting shear loading

**Table C43.1: Characteristic resistance** to **steel failure** under tension or shear loading for **fractional Threaded rods** under seismic action performance category **C1**

| **Threaded rod** | | | | **3/8"** | **1/2"** | **5/8"** | **3/4"** | **7/8"** | **1"** | **1 1/8"** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic resistance to steel failure under tension loading** [1] | | | | | | | | | | |
| **Threaded rods, performance category C1** | | | | | | | | | | |
| Characteristic resistance $N_{Rk,s,C1}$ | Steel zinc plated | Property class | F568M, Class 5.8 | [kN] | 25,0 | 45,7 | 72,9 | 107,9 | 148,9 | 195,4 | 246,0 |
| | | | F1554, Grade 36 | | 19,9 | 36,5 | 58,3 | 86,2 | 119,1 | 156,2 | 196,7 |
| | | | F1554, Grade 55 | | 25,8 | 47,3 | 75,3 | 111,5 | 154,0 | 202,0 | 254,4 |
| | | | F1554, Grade 105 | | 43,0 | 78,8 | 125,6 | 185,9 | 256,7 | 336,8 | 424,0 |
| | | | A193, B7 | | 43,0 | 78,8 | 125,6 | 185,9 | 256,7 | 336,8 | 424,0 |
| | Stainless steel R | | F593, Alloy Group 2 | | 34,4 | 63,0 | 100,5 | 126,4 | 174,5 | 229,0 | 288,3 |
| | | | A193, Grade B8M, Class 1 | | 25,8 | 47,3 | 75,3 | 111,5 | 154,0 | 202,0 | 254,4 |
| | | | A193, Grade B8M, Class 2B | | 32,7 | 59,9 | 95,4 | 141,3 | 195,1 | 255,9 | 322,2 |
| **Characteristic resistance to steel failure under shear loading without lever arm** [1] | | | | | | | | | | |
| **Threaded rods, performance category C1** | | | | | | | | | | |
| Characteristic resistance $V_{Rks,C1}$ | Steel zinc plated | Property class | F568M, Class 5.8 | [kN] | 12,0 | 21,9 | 34,9 | 51,7 | 53,6 | 70,3 | 88,5 |
| | | | F1554, Grade 36 | | 8,3 | 15,3 | 24,4 | 36,2 | 50,0 | 65,6 | 82,6 |
| | | | F1554, Grade 55 | | 10,3 | 18,9 | 30,1 | 44,6 | 46,2 | 60,6 | 76,3 |
| | | | F1554, Grade 105 | | 15,0 | 27,6 | 43,9 | 65,0 | 89,8 | 117,8 | 148,4 |
| | | | A193, B7 | | 17,2 | 31,5 | 50,2 | 74,3 | 77,0 | 101,0 | 127,2 |
| | Stainless steel R | | F593, Alloy Group 2 | | 13,7 | 25,2 | 40,2 | 50,5 | 52,3 | 68,7 | 86,5 |
| | | | A193, Grade B8M, Class 1 | | 10,3 | 18,9 | 30,1 | 44,6 | 46,2 | 60,6 | 76,3 |
| | | | A193, Grade B8M, Class 2B | | 13,1 | 23,9 | 38,1 | 56,5 | 58,5 | 76,7 | 96,6 |

[1] Partial factors for performance category C1 or see table C45.1

**Table C44.1:** Characteristic resistance to **steel failure** under tension / shear loading for **fractional reinforcing bars** under seismic action performance category **C1**

| **Rebar size** | | | **#3** | **#4** | **#5** | **#6** | **#7** | **#8** | **#9** | **#10** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic resistance to steel failure under tension loading [1)]** | | | | | | | | | | |
| **Reinforcing bar materials, performance category C1** | | | | | | | | | | |
| Characteristic resistance $N_{Rk,s,C1}$ | A615 (A767), Grade 40 | [kN] | 29,3 | 53,3 | 82,3 | 117,4 | 160,0 | 210,9 | 266,8 | 338,8 |
| | A615 (A767), Grade 60 | | 44,0 | 80,0 | 123,4 | 176,2 | 240,1 | 316,4 | 400,2 | 508,2 |
| | A615 (A767), Grade 75 | | 48,9 | 88,9 | 137,2 | 195,8 | 266,8 | 351,6 | 444,7 | 564,6 |
| | A706 (A767), Grade 60 | | 39,1 | 71,1 | 109,7 | 156,6 | 213,4 | 281,3 | 355,7 | 451,7 |
| **Characteristic resistance to steel failure under shear loading, without lever arm[1)]** | | | | | | | | | | |
| **Reinforcing bar materials, performance category C1** | | | | | | | | | | |
| Characteristic resistance $V_{Rk,s,C1}$ | A615 (A767), Grade 40 | [kN] | 13,0 | 23,6 | 36,5 | 52,1 | 71,0 | 93,6 | 118,4 | 150,4 |
| | A615 (A767), Grade 60 | | 16,3 | 29,6 | 45,6 | 65,2 | 88,8 | 117,0 | 148,0 | 188,0 |
| | A615 (A767), Grade 75 | | 18,1 | 32,9 | 50,7 | 72,4 | 98,7 | 130,1 | 164,5 | 208,9 |
| | A706 (A767), Grade 60 | | 14,4 | 26,3 | 40,6 | 57,9 | 78,9 | 104,0 | 131,6 | 167,1 |

[1)] Partial factors for performance category C1 see table C45.1.

**Table C45.1: Partial factors for fractional Threaded rods and reinforcing bars under seismic action performance category C1**

| Threaded rod | | | | 3/8" | 1/2" | 5/8" | 3/4" | 7/8" | 1" | 1 1/8" |
|---|---|---|---|---|---|---|---|---|---|---|
| Rebar size | | | | #3 | #4 | #5 | #6 | #7 | #8 | #9 | #10 |
| **Tension loading, steel failure[1)]** | | | | | | | | | | |
| Partial factor $\gamma_{Ms,N}$ | Threaded rod, zinc plated | F568M, Class 5.8 | [-] | 1,50 | | | | | | |
| | | F1554, Grade 36 | | 1,94 | | | | | | |
| | | F1554, Grade 55 | | 1,64 | | | | | | |
| | | F1554, Grade 105 | | 1,43 | | | | | | |
| | | A193, B7 | | 1,43 | | | | | | |
| | Threaded rod, stainless steel R | F593, Alloy Group 2 | | 1,85 | | | | 2,27 | | |
| | | A193, Grade B8M, Class 1 | | 3,00 | | | | | | |
| | | A193, Grade B8M, Class 2B | | 1,52 | | | | | | |
| | Reinforcing bar | A615 (A767), Grade 40 | | 1,80 | | | | | | |
| | | A615 (A767), Grade 60 | | 1,80 | | | | | | |
| | | A615 (A767), Grade 75 | | 1,60 | | | | | | |
| | | A706 (A767), Grade 60 | | 1,60 | | | | | | |
| **Shear loading, steel failure[1)]** | | | | | | | | | | |
| Partial factor $\gamma_{Ms,V}$ | Threaded rod, zinc plated | F568M, Class 5.8 | [-] | 1,25 | | | | | | |
| | | F1554, Grade 36 | | 1,61 | | | | | | |
| | | F1554, Grade 55 | | 1,36 | | | | | | |
| | | F1554, Grade 105 | | 1,50 | | | | | | |
| | | A193, B7 | | 1,50 | | | | | | |
| | Threaded rod, stainless steel R | F593, Alloy Group 2 | | 1,54 | | | | 1,89 | | |
| | | A193, Grade B8M, Class 1 | | 2,50 | | | | | | |
| | | A193, Grade B8M, Class 2B | | 1,27 | | | | | | |
| | Reinforcing bar | A615 (A767), Grade 40 | | 1,50 | | | | | | |
| | | A615 (A767), Grade 60 | | 1,50 | | | | | | |
| | | A615 (A767), Grade 75 | | 1,33 | | | | | | |
| | | A706 (A767), Grade 60 | | 1,33 | | | | | | |

[1)] In absence of other national regulations.

**Table C46.1:** Characteristic **resistance** for **combined pull-out** and **concrete failure** for **fractional Threaded rods** in hammer drilled holes under seismic action performance category **C1; working life 50 years**

| **Threaded rod** | | | | **3/8"** | **1/2"** | **5/8"** | **3/4"** | **7/8"** | **1"** | **1 1/8"** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic bond resistance, combined pull-out and concrete cone failure** | | | | | | | | | | |
| **Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete)** | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,C1}$ | [N/mm²] | 8,5 | 9,0 | 9,1 | 8,5 | 8,5 | 8,2 | 7,1 |
| | II: 35 °C / 60 °C | | | 8,5 | 9,0 | 9,1 | 8,5 | 8,5 | 8,2 | 7,1 |
| | III: 50 °C / 72 °C | | | 8,0 | 8,5 | 8,5 | 8,5 | 8,5 | 8,2 | 7,1 |
| **Hammer-drilling with standard drill bit or hollow drill bit (water filled hole)** | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,C1}$ | [N/mm²] | 7,4 | 7,7 | 7,5 | 6,0 | 6,0 | 5,8 | 5,0 |
| | II: 35 °C / 60 °C | | | 7,4 | 7,7 | 7,5 | 6,0 | 6,0 | 5,8 | 5,0 |
| | III: 50 °C / 72 °C | | | 6,9 | 7,3 | 7,0 | 6,0 | 6,0 | 5,8 | 5,0 |
| **Installation factors** | | | | | | | | | | |
| **Tension loading** | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | |
| Water filled hole | | | | 1,2 | | | 1,4 | | | |

**Table C46.2:** Characteristic **resistance** for **combined pull-out** and **concrete failure** for **fractional Threaded rods** in hammer drilled holes under seismic action performance category **C1; working life 100 years**

| **Threaded rod** | | | | **3/8"** | **1/2"** | **5/8"** | **3/4"** | **7/8"** | **1"** | **1 1/8"** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic bond resistance, combined pull-out and concrete cone failure** | | | | | | | | | | |
| **Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete)** | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,C1}$ | [N/mm²] | 6,8 | 6,8 | 6,9 | 6,9 | 6,8 | 6,3 | 5,3 |
| | II: 35 °C / 60 °C | | | 6,8 | 6,8 | 6,9 | 6,9 | 6,8 | 6,3 | 5,3 |
| | III: 50 °C / 72 °C | | | 6,4 | 6,4 | 6,5 | 6,4 | 6,4 | 5,9 | 5,1 |
| **Hammer-drilling with standard drill bit or hollow drill bit (water filled hole)** | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,C1}$ | [N/mm²] | 5,9 | 5,9 | 5,7 | 4,9 | 4,8 | 4,4 | 3,7 |
| | II: 35 °C / 60 °C | | | 5,9 | 5,9 | 5,7 | 4,9 | 4,8 | 4,4 | 3,7 |
| | III: 50 °C / 72 °C | | | 5,5 | 5,5 | 5,3 | 4,5 | 4,5 | 4,2 | 3,6 |
| **Installation factors** | | | | | | | | | | |
| **Tension loading** | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | |
| Water filled hole | | | | 1,2 | | | 1,4 | | | |

**Table C47.1:** Characteristic **resistance** for **combined pull-out** and **concrete failure** for **fractional reinforcing bars** in hammer drilled holes under seismic action performance category **C1; working life 50 years**

| **Rebar size** | | | | **#3** | **#4** | **#5** | **#6** | **#7** | **#8** | **#9** | **#10**[1)] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic bond resistance, combined pull-out and concrete cone failure** | | | | | | | | | | | |
| **Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete)** | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,C1}$ | [N/mm²] | 6,2 | 7,0 | 7,0 | 7,0 | 7,0 | 7,0 | 7,0 | 7,0 |
| | II: 35 °C / 60 °C | | | 6,2 | 7,0 | 7,0 | 7,0 | 7,0 | 7,0 | 7,0 | 7,0 |
| | III: 50 °C / 72 °C | | | 6,2 | 7,0 | 7,0 | 7,0 | 7,0 | 7,0 | 7,0 | 7,0 |
| **Hammer-drilling with standard drill bit or hollow drill bit (water filled hole)** | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,C1}$ | [N/mm²] | 6,6 | 5,7 | 5,7 | 5,3 | 5,3 | 5,3 | 5,3 | 4,4 |
| | II: 35 °C / 60 °C | | | 6,6 | 5,7 | 5,7 | 5,3 | 5,3 | 5,3 | 5,3 | 4,4 |
| | III: 50 °C / 72 °C | | | 5,7 | 5,7 | 5,3 | 5,3 | 5,3 | 5,3 | 5,3 | 4,4 |
| **Installation factors** | | | | | | | | | | | |
| **Tension loading** | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |
| Water filled hole | | | | 1,2 | | | 1,4 | | | | |

[1)] Not allowed for drilling with hollow drill bit.

**Table C47.2:** Characteristic **resistance** for **combined pull-out** and **concrete failure** for **fractional reinforcing bars** in hammer drilled holes under seismic action performance category **C1; working life 100 years**

| **Rebar size** | | | | **#3** | **#4** | **#5** | **#6** | **#7** | **#8** | **#9** | **#10**[1)] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic bond resistance, combined pull-out and concrete cone failure** | | | | | | | | | | | |
| **Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete)** | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,C1}$ | [N/mm²] | 5,2 | 5,6 | 4,6 | 4,6 | 4,6 | 4,6 | 4,6 | 4,6 |
| | II: 35 °C / 60 °C | | | 5,2 | 5,6 | 4,6 | 4,6 | 4,6 | 4,6 | 4,6 | 4,6 |
| | III: 50 °C / 72 °C | | | 5,2 | 5,6 | 4,6 | 4,6 | 4,6 | 4,6 | 4,6 | 4,6 |
| **Hammer-drilling with standard drill bit or hollow drill bit (water filled hole)** | | | | | | | | | | | |
| Temperature range | I: 24 °C / 40 °C | $\tau_{Rk,C1}$ | [N/mm²] | 5,6 | 4,6 | 3,7 | 3,4 | 3,4 | 3,4 | 3,4 | 2,9 |
| | II: 35 °C / 60 °C | | | 5,6 | 4,6 | 3,7 | 3,4 | 3,4 | 3,4 | 3,4 | 2,9 |
| | III: 50 °C / 72 °C | | | 4,9 | 4,6 | 3,4 | 3,4 | 3,4 | 3,4 | 3,4 | 2,9 |
| **Installation factors** | | | | | | | | | | | |
| **Tension loading** | | | | | | | | | | | |
| Dry or wet concrete | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |
| Water filled hole | | | | 1,2 | | | 1,4 | | | | |

[1)] Not allowed for drilling with hollow drill bit.

**Table C48.1: Fire resistance to steel failure under tension and shear loading for metric Anchor rods and Threaded rods part 1**

**Fire resistance to steel failure under tension and shear loading**

| **Anchor rod / Threaded rod ISO 898-1 Class 5.8 and higher** | **R30** | | | **R60** | | |
|---|---|---|---|---|---|---|
| | $N_{Rk,s,fi,30}$ [kN] | $V_{Rk,s,fi,30}$ [kN] | $M^0_{Rk,s,fi,30}$ [Nm] | $N_{Rk,s,fi,60}$ [kN] | $V_{Rk,s,fi,60}$ [kN] | $M^0_{Rk,s,fi,60}$ [Nm] |
| M8 | 1,6 | 1,6 | 1,7 | 1,2 | 1,2 | 1,2 |
| M10 | 3,3 | 3,3 | 4,2 | 2,3 | 2,3 | 3,0 |
| M12 | 5,8 | 5,8 | 9,1 | 4,0 | 4,0 | 6,2 |
| M14 | 6,6 | 6,6 | 12,0 | 4,6 | 4,6 | 8,4 |
| M16 | 10,9 | 10,9 | 15,1 | 7,5 | 7,5 | 11,2 |
| M20 | 11,1 | 11,1 | 29,4 | 8,2 | 8,2 | 21,8 |
| M22 | 13,7 | 13,7 | 40,5 | 10,1 | 10,1 | 30,0 |
| M24 | 16,0 | 16,0 | 50,9 | 11,8 | 11,8 | 37,7 |
| M27 | 20,8 | 20,8 | 75,5 | 15,4 | 15,4 | 56,0 |
| M30 | 25,4 | 25,4 | 102,0 | 18,8 | 18,8 | 75,6 |
| **Anchor rod / Threaded rod ISO 898-1 Class 5.8 and higher** | **R90** | | | **R120** | | |
| | $N_{Rk,s,fi,90}$ [kN] | $V_{Rk,s,fi,90}$ [kN] | $M^0_{Rk,s,fi,90}$ [Nm] | $N_{Rk,s,fi,120}$ [kN] | $V_{Rk,s,fi,120}$ [kN] | $M^0_{Rk,s,fi,120}$ [Nm] |
| M8 | 0,8 | 0,8 | 0,8 | 0,6 | 0,6 | 0,6 |
| M10 | 1,4 | 1,4 | 1,8 | 0,9 | 0,9 | 1,1 |
| M12 | 2,1 | 2,1 | 3,3 | 1,2 | 1,2 | 1,9 |
| M14 | 2,7 | 2,7 | 4,9 | 1,7 | 1,7 | 3,2 |
| M16 | 4,0 | 4,0 | 7,3 | 2,3 | 2,3 | 5,3 |
| M20 | 5,3 | 5,3 | 14,2 | 3,9 | 3,9 | 10,4 |
| M22 | 6,6 | 6,6 | 19,5 | 4,8 | 4,8 | 14,3 |
| M24 | 7,7 | 7,7 | 24,6 | 5,6 | 5,6 | 18,0 |
| M27 | 10,0 | 10,0 | 36,4 | 7,3 | 7,3 | 26,7 |
| M30 | 12,3 | 12,3 | 49,3 | 9,0 | 9,0 | 36,1 |

**Table C49.1: Fire resistance to steel failure under tension and shear loading for metric Anchor rods and Threaded rods part 2**

| Anchor rods R and HCR and Threaded rod, EN ISO 3506-1 Class A4-50 and higher | R30 | | | R60 | | |
|---|---|---|---|---|---|---|
| | $N_{Rk,s,fi,30}$ [kN] | $V_{Rk,s,fi,30}$ [kN] | $M^0_{Rk,s,fi,30}$ [Nm] | $N_{Rk,s,fi,60}$ [kN] | $V_{Rk,s,fi,60}$ [kN] | $M^0_{Rk,s,fi,60}$ [Nm] |
| M8 | 0,7 | 0,7 | 0,7 | 0,5 | 0,5 | 0,6 |
| M10 | 1,4 | 1,4 | 1,8 | 1,1 | 1,1 | 1,5 |
| M12 | 2,5 | 2,5 | 3,9 | 2,1 | 2,1 | 3,9 |
| M14 | 3,4 | 3,4 | 6,2 | 2,8 | 2,8 | 6,2 |
| M16 | 4,7 | 4,7 | 9,9 | 3,9 | 3,9 | 9,9 |
| M20 | 7,3 | 7,3 | 19,4 | 6,1 | 6,1 | 19,4 |
| M22 | 9,0 | 9,0 | 26,7 | 7,5 | 7,5 | 26,7 |
| M24 | 10,5 | 10,5 | 33,6 | 8,8 | 8,8 | 28,0 |
| M27 | 13,7 | 13,7 | 49,9 | 11,4 | 11,4 | 41,6 |
| M30 | 16,8 | 16,8 | 67,4 | 14,0 | 14,0 | 56,2 |
| **Anchor rods R and HCR and Threaded rod, EN ISO 3506-1 Class A4-50 and higher** | **R90** | | | **R120** | | |
| | $N_{Rk,s,fi,90}$ [kN] | $V_{Rk,s,fi,90}$ [kN] | $M^0_{Rk,s,fi,90}$ [Nm] | $N_{Rk,s,fi,120}$ [kN] | $V_{Rk,s,fi,120}$ [kN] | $M^0_{Rk,s,fi,120}$ [Nm] |
| M8 | 0,4 | 0,4 | 0,4 | 0,3 | 0,3 | 0,3 |
| M10 | 0,9 | 0,9 | 1,2 | 0,8 | 0,8 | 1,0 |
| M12 | 1,6 | 1,6 | 3,9 | 1,3 | 1,3 | 3,9 |
| M14 | 2,3 | 2,3 | 6,2 | 1,8 | 1,8 | 6,2 |
| M16 | 3,1 | 3,1 | 9,9 | 2,5 | 2,5 | 9,9 |
| M20 | 4,9 | 4,9 | 19,4 | 3,9 | 3,9 | 19,4 |
| M22 | 6,0 | 6,0 | 26,7 | 4,8 | 4,8 | 26,7 |
| M24 | 7,0 | 7,0 | 22,4 | 5,6 | 5,6 | 17,9 |
| M27 | 9,1 | 9,1 | 33,2 | 7,3 | 7,3 | 26,6 |
| M30 | 11,2 | 11,2 | 44,9 | 8,9 | 8,9 | 35,9 |

**Table C50.1: Fire resistance to steel failure under tension and shear loading for fractional Threaded rods**

| Fire resistance to steel failure under tension and shear loading | | | | | | |
|---|---|---|---|---|---|---|
| **Threaded rod** | **R30** | | | **R60** | | |
| Steel zinc plated; detailed materials see Table A7.1, part No 2 [1)] | $N_{Rk,s,fi,30}$ [kN] | $V_{Rk,s,fi,30}$ [kN] | $M^0_{Rk,s,fi,30}$ [Nm] | $N_{Rk,s,fi,60}$ [kN] | $V_{Rk,s,fi,60}$ [kN] | $M^0_{Rk,s,fi,60}$ [Nm] |
| 3/8" | 2,7 | 2,7 | 3,2 | 1,9 | 1,9 | 2,3 |
| 1/2" | 5,9 | 5,9 | 9,6 | 4,1 | 4,1 | 6,7 |
| 5/8" | 6,7 | 6,7 | 13,7 | 4,9 | 4,9 | 10,1 |
| 3/4" | 9,7 | 9,7 | 24,3 | 7,2 | 7,2 | 18,0 |
| 7/8" | 13,5 | 13,5 | 39,4 | 10,0 | 10,0 | 29,2 |
| 1" | 17,7 | 17,7 | 59,3 | 13,1 | 13,1 | 43,9 |
| 1 1/8" | 22,3 | 22,3 | 83,8 | 16,5 | 16,5 | 62,2 |
| **Threaded rod** | **R90** | | | **R120** | | |
| Steel zinc plated; detailed materials see Table A7.1, part No 2 [1)] | $N_{Rk,s,fi,90}$ [kN] | $V_{Rk,s,fi,90}$ [kN] | $M^0_{Rk,s,fi,90}$ [Nm] | $N_{Rk,s,fi,120}$ [kN] | $V_{Rk,s,fi,120}$ [kN] | $M^0_{Rk,s,fi,120}$ [Nm] |
| 3/8" | 1,1 | 1,1 | 1,4 | 0,8 | 0,8 | 0,9 |
| 1/2" | 2,3 | 2,3 | 3,7 | 1,3 | 1,3 | 2,2 |
| 5/8" | 3,6 | 3,6 | 7,5 | 2,2 | 2,2 | 4,5 |
| 3/4" | 4,7 | 4,7 | 11,7 | 3,4 | 3,4 | 8,6 |
| 7/8" | 6,5 | 6,5 | 19,0 | 4,7 | 4,7 | 13,9 |
| 1" | 8,5 | 8,5 | 28,6 | 6,2 | 6,2 | 20,9 |
| 1 1/8" | 10,7 | 10,7 | 40,5 | 7,9 | 7,9 | 29,6 |
| **Threaded rod** | **R30** | | | **R60** | | |
| Stainless steel R; detailed materials see Table A7.1, part No 2 | $N_{Rk,s,fi,30}$ [kN] | $V_{Rk,s,fi,30}$ [kN] | $M^0_{Rk,s,fi,30}$ [Nm] | $N_{Rk,s,fi,60}$ [kN] | $V_{Rk,s,fi,60}$ [kN] | $M^0_{Rk,s,fi,60}$ [Nm] |
| 3/8" | 1,1 | 1,1 | 1,4 | 0,9 | 0,9 | 1,1 |
| 1/2" | 2,7 | 2,7 | 4,4 | 2,2 | 2,2 | 3,7 |
| 5/8" | 4,3 | 4,3 | 8,9 | 3,6 | 3,6 | 7,4 |
| 3/4" | 6,4 | 6,4 | 16,1 | 5,4 | 5,4 | 13,4 |
| 7/8" | 8,9 | 8,9 | 26,1 | 7,4 | 7,4 | 21,7 |
| 1" | 11,7 | 11,7 | 39,2 | 9,7 | 9,7 | 32,6 |
| 1 1/8" | 14,7 | 14,7 | 55,4 | 12,3 | 12,3 | 46,2 |
| **Threaded rod** | **R90** | | | **R120** | | |
| Stainless steel R; detailed materials see Table A7.1, part No 2 | $N_{Rk,s,fi,90}$ [kN] | $V_{Rk,s,fi,90}$ [kN] | $M^0_{Rk,s,fi,90}$ [Nm] | $N_{Rk,s,fi,120}$ [kN] | $V_{Rk,s,fi,120}$ [kN] | $M^0_{Rk,s,fi,120}$ [Nm] |
| 3/8" | 0,7 | 0,7 | 0,9 | 0,6 | 0,6 | 0,7 |
| 1/2" | 1,8 | 1,8 | 2,9 | 1,4 | 1,4 | 2,3 |
| 5/8" | 2,9 | 2,9 | 5,9 | 2,3 | 2,3 | 4,7 |
| 3/4" | 4,3 | 4,3 | 10,7 | 3,4 | 3,4 | 8,5 |
| 7/8" | 5,9 | 5,9 | 17,4 | 4,7 | 4,7 | 13,9 |
| 1" | 7,8 | 7,8 | 26,1 | 6,2 | 6,2 | 20,9 |
| 1 1/8" | 9,8 | 9,8 | 36,9 | 7,8 | 7,8 | 29,5 |

[1)] No performance assessed for ASTM F1554 Grade 36.

## Characteristic bond resistance for cracked concrete under fire conditions for metric and fractional Anchor rods and Threaded rods in hammer drilled holes with standard drill bit or hollow drill bit

The characteristic bond resistance for cracked concrete under fire conditions for a given temperature $\tau_{Rk,fi}(\theta)$ has to be calculated by the following equation:

$$\tau_{Rk,fi}(\theta) = k_{fi,p}(\theta) \cdot \tau_{Rk,cr,C20/25}$$

| | | |
|---|---|---|
| $\theta$ | = | Temperature in °C in the mortar layer |
| $\tau_{Rk,fi}(\theta)$ | = | Characteristic bond resistance for cracked concrete under fire exposure for a given temperature in N/mm² for concrete classes C20/25 to C50/60 |
| $k_{fi,p}(\theta)$ | = | Reduction factor under fire conditions |
| $\tau_{Rk,cr,C20/25}$ | = | Characteristic bond resistance for cracked concrete C20/25 in N/mm², given in Table C5.1, Table C6.1, Table C26.1 or Table C28.1, respectively |

| | | | |
|---|---|---|---|
| Anchor rods or Threaded rods | If: $\theta$ > 21 °C | $\mathbf{k_{fi,p}(\theta) = 26{,}71 \cdot \theta^{-1{,}166} \leq 1{,}0}$ | see Figure C51.1 |
| | If: $\theta > \theta_{max}$ = 284 °C | $\mathbf{k_{fi,p}(\theta) = 0}$ | |

**Figure C51.1:** Graph of reduction factor $k_{fi,p}(\theta)$ for Anchor rods or Threaded rods